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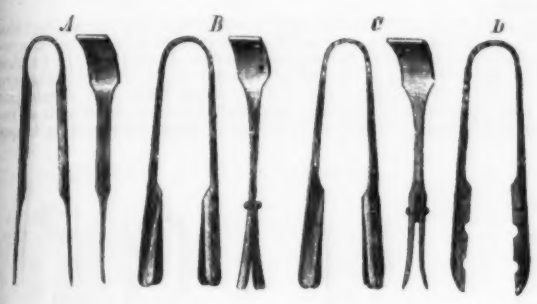
## MANUFACTURE OF GLASSWARE.

In this article we will not touch at all upon the substances used in the composition of glass, nor the furnaces employed for their fusion, but will speak of some of the tools used by the glassworker, among which we may include the chair on which he sits while at work, rolling the blow-pipe back and forth on the two arms with his left hand, while he fashions the glass on the end of it with his right hand. Some of the other tools are shown in Fig. 1, which gives a profile and a side view of each utensil. A represents the tongs used in distending the sides of vessels, laying back the edges, etc.; B is used in placing rings around the necks of carafes or decanters, and also in forming the stems of glasses; C is for rounding simple bottoms of wine glasses, goblets, etc.; D, tongs with sharp blades, also used in making stems of wine glasses; E is used in evening rings that have been laid on; G, pincers for taking hold of, drawing out and pinching off the glass mass; H, a flap iron plate for evening straight surfaces; and J, shears.

In Fig. 2 we have the tongs used in shaping stems or legs. The two parts, A, A, have corresponding grooves by means of which the form is given to the stems, the members being pressed together while the stem is turned. The work is thus greatly facilitated and the stems of the glasses are made of a uniform length. Different shapes can be given to the stems by varying the forms of the grooves.

We will now describe the process of making so-called "stem glasses." By dipping the pipe twice in the pot of molten glass, the workman takes out the necessary quantity of glass, which he works on the marver, turning the pipe in the meantime so that the upper part becomes weaker, while the strength of the glass gradually increases toward the lower end. The glass bulb thus formed is allowed to cool slightly, and is then blown into a wet wooden mould, taking its form exactly (Fig. 3). It is important that the glass should be cooled before it is blown, as this method of treatment gives a luster and brightness to the surface of the glass; whereas the surface is apt to have a frosted or dull appearance if blown while too hot. Next follows the formation of the leg, for which two different processes are employed. If the bowl part blown as just described is broad at the bottom, as in Fig. 3, the lump of glass for the leg is taken up on the working rod and fastened to the bottom of the bowl; but if this bottom is pointed, the point is dipped into the molten glass and the proper amount taken out without the use of the working rod. This latter method is, of course, simpler. In forming the stem the operator turns the pipe constantly while using the tool marked B in Fig. 1 to round the glass close to the bowl, and form the knob, as shown in Fig. 5. The stems are shaped in different ways, but the most perfect forms are obtained



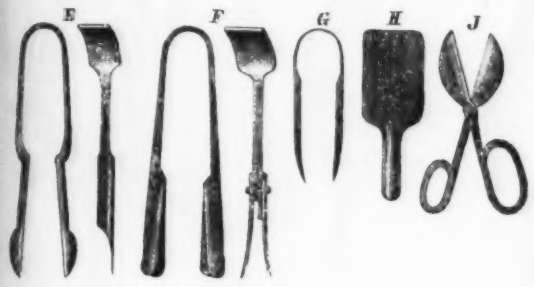




FIG. 1.

FIG. 6.

FIG. 7.

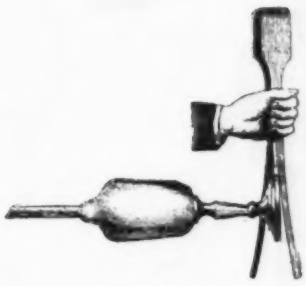


FIG. 8.

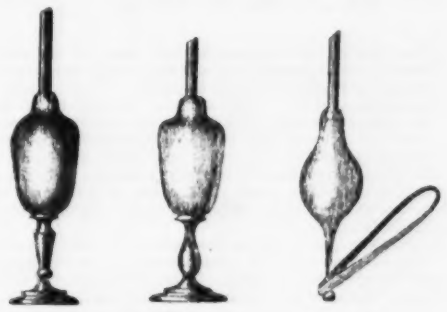


FIG. 9. FIG. 10. FIG. 11.

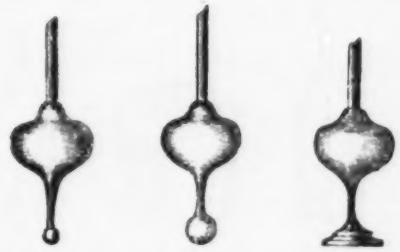


FIG. 12. FIG. 13. FIG. 14.

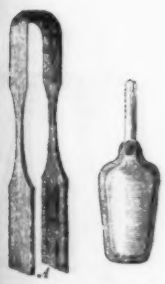


FIG. 4.

FIG. 2. FIG. 3.

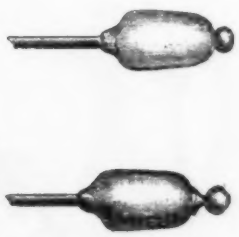


FIG. 5.

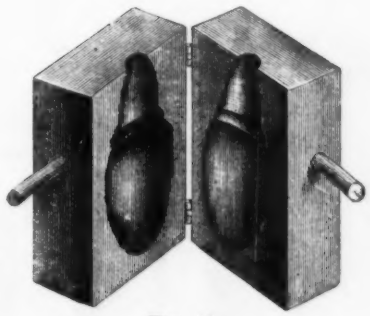


FIG. 15.

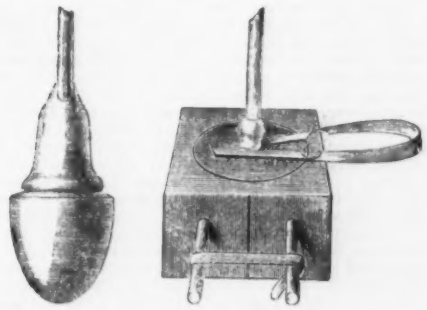


FIG. 16. FIG. 17.

FIG. 18. FIG. 19. FIG. 20.

FIG. 23.

FIG. 21. FIG. 22. FIG. 24.

FIG. 25. FIG. 26.

by the use of the shears shown in Fig. 2, with which the entire stem and the round part at its joint with the bowl are formed at the same time. When the stem has been formed, as shown in Fig. 6, the end of it is dipped into the melted glass, enough of which adheres to it to form the foot (Fig. 7). This mass is flattened and shaped as shown in Fig. 8. Figs. 9 and 10 show stems of different shapes. Much attention

FIG. 30.

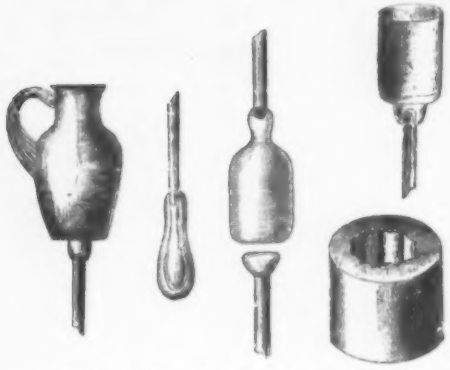


FIG. 27. FIG. 28. FIG. 29. FIG. 31.

has lately been given to this part of the glass, the simple, delicate and smooth high stem being preferred on account of its elegant appearance, and these stems are produced in a very simple manner if no head is formed where they start from the bowl. By working the bulb a little knob is formed which the operator draws out while it is still in a heated state, as shown in Fig. 11, and then this stem is blown out, as shown in Fig. 12. A quantity of glass is gathered on the point of the stem (Fig. 13), from which the foot is made (Fig. 14).

Now we will describe the process of making a pitcher. Fig. 15 represents the wooden mould for the upper part of the pitcher, and Fig. 16 shows this part after it has been blown in the mould. At the same time that this upper part is being made a second operator is blowing the lower part in another mould, an apprentice making a cut just below the blow-pipe, while the glass is being turned in the mould (Fig. 17), so that the knob can be more easily broken off when the time comes. The ends of the two parts thus blown are heated slightly and welded together by pressure. The upper part is sev-

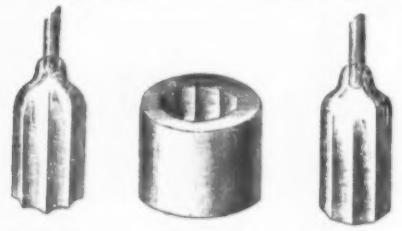


FIG. 32. FIG. 33. FIG. 34.

ered from the blow-pipe on the dotted line in Fig. 18. This open part is softened by being heated, the little opening enlarged, heated again, the edge trimmed (Fig. 19), and then the lip shaped (Fig. 20).

Next follows the formation of the handle. The assistant takes a quantity of glass on the working rod and rolls it into the form of a cylinder, which he holds perpendicularly while the workman holds the pitcher horizontally under it, so that the end of the soft cylinder touches the rim opposite the lip, to which it is welded by pressure. After a piece has been cut off, leaving the proper length for the handle, the free end of this cylinder is attached to the pitcher directly below the end which has already been welded to the rim, and while still soft it can be given any desired shape (Figs. 21 and 22). For making fluted handles a mould is used that is like that shown in Fig. 23, being provided with ridges and grooves that meet in a point at the bottom of the mould. The glass from which the handle is to be made is placed in this mould and subjected to pressure, so that corrugations are made in it, as indicated in Fig. 24. This corrugated cylinder is pressed upon the large part

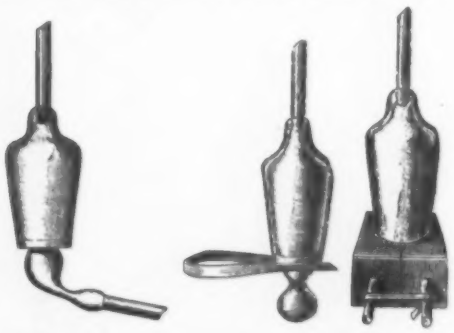


FIG. 35. FIG. 36. FIG. 37.

of the pitcher or other article (Fig. 25), and then it is drawn out and cut from the working rod (Fig. 26), and the cut end fastened to the edge of the pitcher, and then this handle is properly curved. Fig. 27 shows a simple little pitcher with a fluted handle.

For forming ordinary tumblers, the operator elongates the ball of glass (Fig. 28), which he then blows into the form shown in Fig. 29, and fastens to a holding rod, or grasps it with pincers, and then severs it from the blow-pipe. This upper end is then heated, trimmed off and expanded (Fig. 30). With the better wares the tumbler is not expanded afterward, but is entirely shaped in the mould, the edge being ground and polished. In cut glass angular facets are formed, but the walls of the vessel must, of course, be stronger for this kind of decoration.

In the modern pressed glass we see many imitations of cut glass, but work of this kind should be forced out of market by the more beautiful and practical pressed glass. A pressed tumbler is made in the following manner: The operator gathers the proper quantity of glass, and after working it presses it into the wooden mould (Fig. 31), blowing it very hard, so that the glass takes the form of the mould, having sharp angles with rounded faces between (Fig. 32). The second mould, which may also be of wood, but is preferably of iron, has the same number of angles, but the faces between them are straight instead of curved (Fig. 33). The lump of glass is properly heated in the furnace and elongated by being swung like a pendulum—whereby a better luster is given to the surface of the glass—and then it is blown hard in the second mould, the pipe being held still in the meantime. This pressing must be carefully done, so that the angles made by the first mould will fit those of the second mould, for otherwise the effect would be lost. Fig. 24 shows a tumbler after it has been taken from the second mould.

Figs. 35 to 38 illustrate the process of making a common goblet. After the upper part has been blown in a suitable mould, the foot is formed in the following manner: A large lump of glass is gathered on the working rod and then fastened to the bottom of the goblet bowl (Fig. 35), then the working rod is freed and the glass rounded and shaped as shown in Fig. 36. A wooden mould (Fig. 37) is used for shaping the foot, the blow-pipe being turned while the foot is being shaped in the closed mould. There are other methods by which the foot and the upper part are blown separately and then joined, but when made in this way the bottoms of the goblets are never as even as when made by the method above described. Fig. 38 shows the foot completed.

The device shown in Fig. 39 is used in forming longitudinal ridges in carafes and other articles. It consists of strong pieces of metal plate fastened, equal distances apart, to an iron hoop. These pieces are rounded out at the bottom and come together so as to form a star.

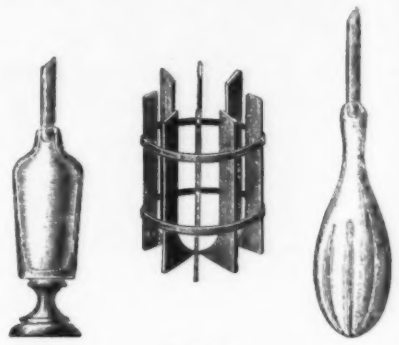


FIG. 38. FIG. 39. FIG. 40.

Solid moulds can also be used for this purpose, but the kind shown in Fig. 39 is cheaper and meets all the requirements. The glass bulb is blown gently in this mould, so that the parts between the metal plates are made to bulge out. When taken from this mould the glass bulb is placed in another mould, in which it receives the form of a carafe, after which it is taken

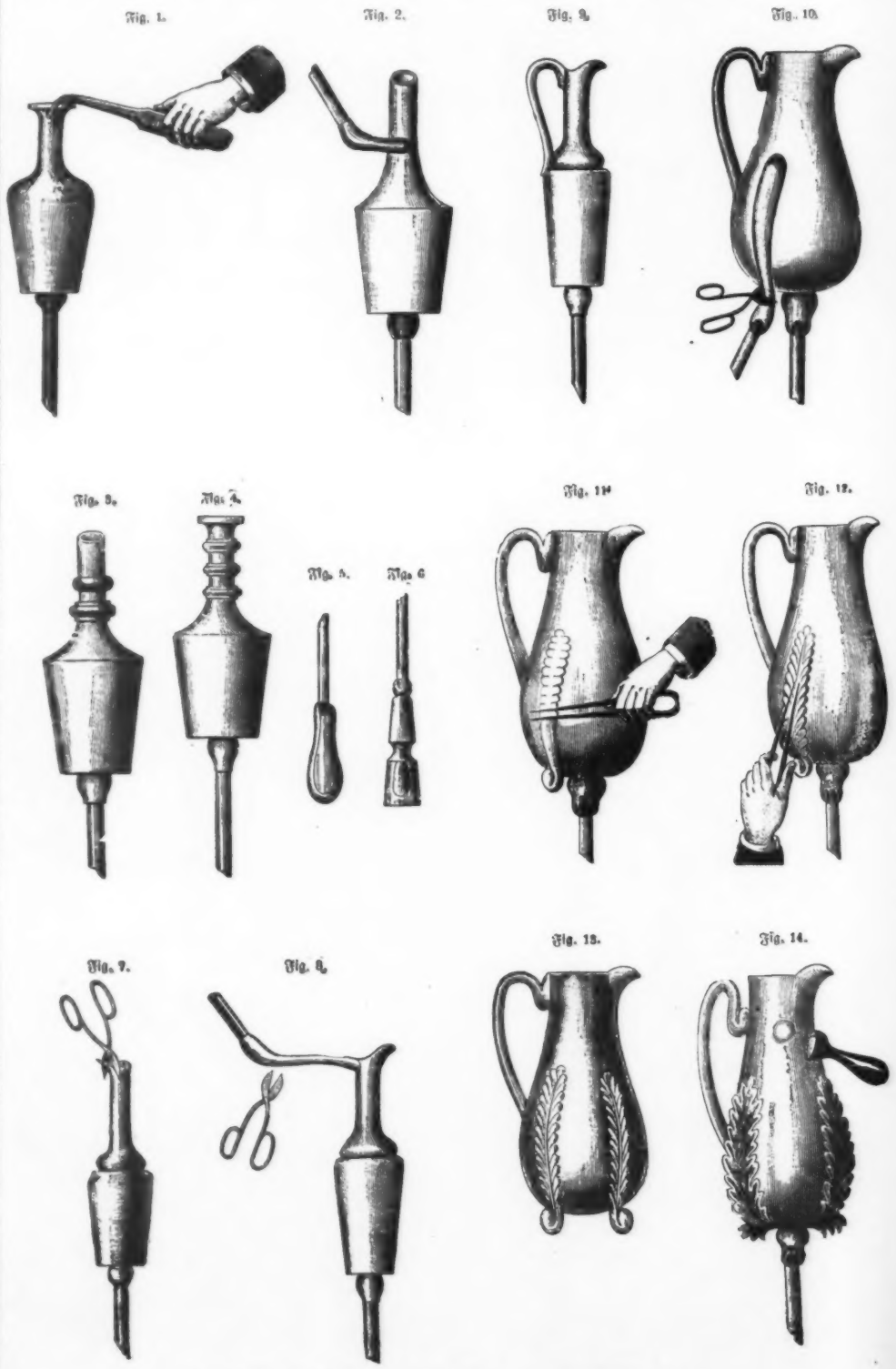



PLATE I.—MANUFACTURE OF GLASSWARE.

from the mould, the pipe is cut off and the lip formed.

A decanter is blown in the form shown in Fig. 42, a holding iron is fastened to the bottom, and then the

FIG. 41.

FIG. 42.

neck is severed from the blow-pipe, and the lip formed, as shown in Fig. 1 (Plate I.) Figs. 2, 3 and 4 (Plate I.) illustrate the process of ornamenting the neck of the decanter with rings. Articles of this class are frequently made strong and then cut. Figs. 5 and 6 (Plate I.) represent the stopper for the decanter in process of manufacture. Fig. 7 shows the method of forming the lip of a small pitcher, after it has been properly heated, and Figs. 8 and 9 show the same pitcher approaching completion. Figs. 10 to 15 inclusive (Plates I. and II.) illustrate the methods of decorating pitchers. The instrument shown in Fig. 14 is a metal die used for forming heads, etc., of the lumps of glass which are placed on the sides of the pitcher while in a soft condition. In Figs. 16 and 17 (Plate II.) we see the upper and lower parts of a teapot after they have been blown in the respective moulds, and Figs. 18, 19, 20 and 21 enable us to follow the other steps taken in the completion of the teapot. The mass of glass from which the spout is to be formed is placed against the side of the teapot while very hot, and its heat softens the glass against which the mass rests, so that by blowing through the blow-pipe an opening is made in the said wall and the spout is hollowed out.

In making a twisted handle, the lump of soft glass is fastened to the pitcher in the proper place, and then is divided lengthwise into two parts which are drawn out and twisted, and then the free end is fastened to the side of the pitcher directly below the other end (Figs. 22 to 25 inclusive, Plate II.) Figs. 26 to 32 inclusive (Plate II.) illustrate the process of forming twisted, straight and looped stems for wine glasses, goblets, etc. In Fig. 33 we see a pitcher with a snake handle, which is made in very much the same way as the other handles already described. The pitcher must be well heated, so as to provide for the perfect adhesion of the handle to the walls of the pitcher.

Wavy rings are often used as a decoration on glass ware, and they are quite simply made. After gathering the mass of glass on the working rod the operator rolls and elongates it, and then places it around the pitcher or other article so as to form a ring, and then, while still in a soft state, he forms the waves, as shown in Fig. 34 (Plate II.), by placing the points of the pincers on either side of the ring and turning the tool first to one side and then to the other. This work must be done quickly before the ring has time to cool. For the accompanying illustrations we are indebted to our well-known contemporary *Der Stein der Weisen.*

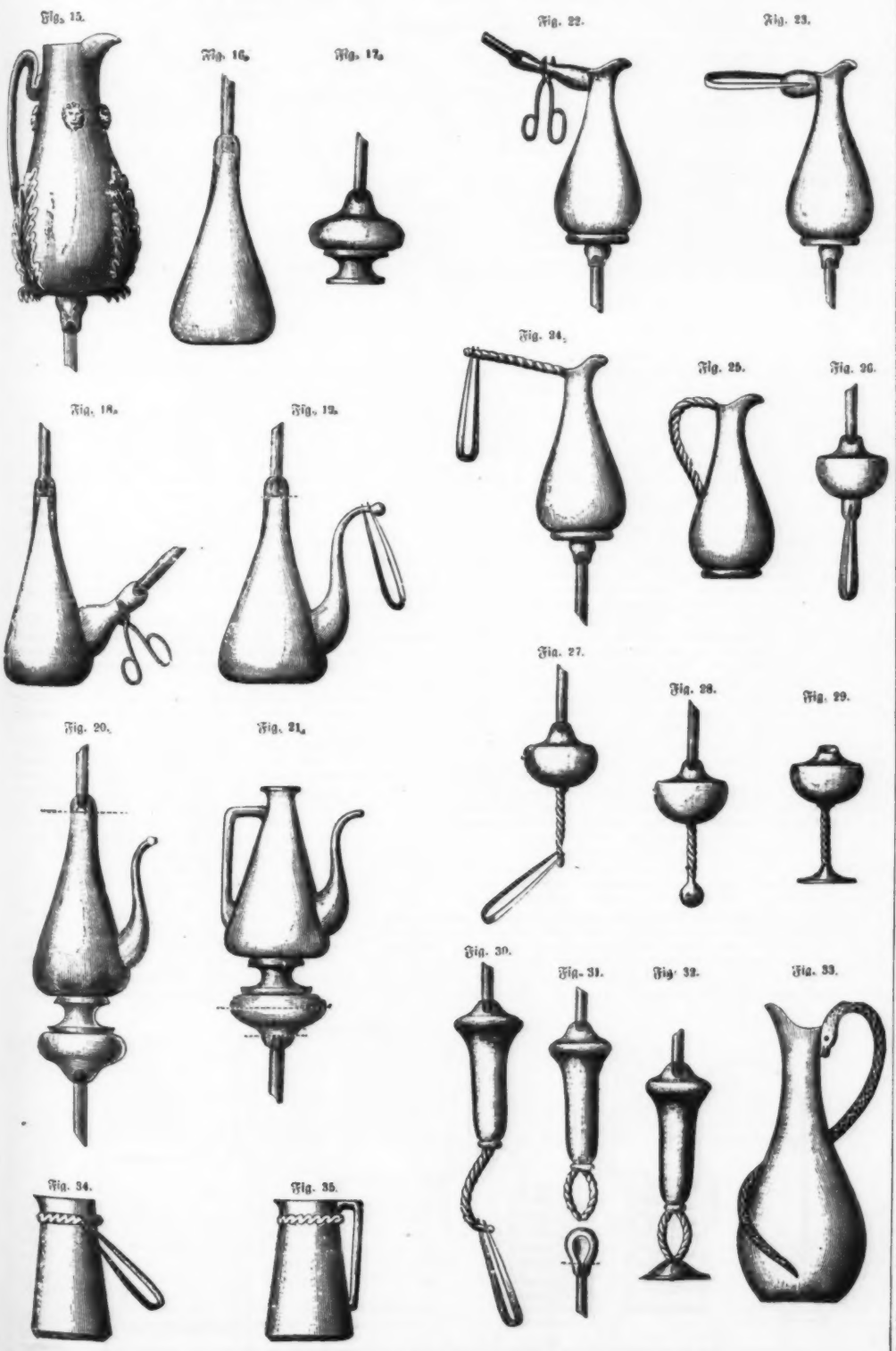



PLATE II.—MANUFACTURE OF GLASSWARE.

## THE DROST AND SCHULZ PROCESS.*

IT consists essentially of three operations, by the aid of which raw sugar is transformed into pure crystallized sugar and molasses without loss, while the wash enters again into the process without any treatment. The raw sugar to be handled is mixed with molasses of seventy to seventy-two purity, derived from a previous operation, and there is thus made a sort of masse cuite. The molasses destined to this operation must necessarily be brought to a specific gravity of 1·33, or 68 to 70 Balling.

By this mixing the molasses adhering to the crystals is slightly liquefied and rendered more apt to separate from the crystals in the centrifugals. The raw sugar thus mixed is dropped into the centrifugals, and when the centrifugaling is finished a little steam is injected between the drum and the shell of the apparatus to promote the discharge of the molasses by warming the apparatus, and in order to maintain a certain humidity and cleanness of the interior surface of the shell, promoting the outflow of the molasses projected thereon.

Under the influence of the rapid rotation of the centrifugals all of the sirup of the mixed mass and the largest part of the molasses adhering to the raw sugar thus rendered fluid is discharged and there remains in the apparatus raw sugars polarizing at least 98 per cent.

Thus then, by this first operation, the sirup or molasses attached to the raw sugar, which is its most impure part, is almost entirely separated by the work, and, as we shall see later, this sirup is the first and only residuary product of the process. It is treated, as previously stated, by employing it in the mixing of new raw sugar for the centrifugals.

In the second operation, which constitutes the washing, properly so called, one proceeds as follows: The liquid intended for the wash is a thin solution of raw sugar, but of a tint more or less yellow or brown, and which, with a view of favoring its action, has been previously filtered in bag filters or with bone black. Its specific gravity should be 1·325.

With this liquid, which possesses a purity of at least 95, while the sirup to be driven has a purity of about 72, the sugar in the centrifugal is washed. From 12 to 14 per cent. of the weight of raw sugar is used of this wash. After this washing the sugar will be almost white and polarizing from 99·2 to 99·8.

This operation of washing terminates the second operation of the work. It is clear that from the concentration of the wash no solution of sugar crystals can take place, and consequently all the crystallized sugar is obtained in sugar polarizing 99·2 to 99·8 per cent., with no other loss.

The third operation then begins; the application during one to two minutes of a wash of steam, the purpose of which is to transform the sugar into sugar fit for consumption and testing 100 per cent. by the polariscope, or to dry the sugar for the production of cubes.

By this washing with steam it is true that from 1 to 1½ per cent. of pure sugar is dissolved, but this dissolved sugar is found in the resulting wash. The first wash is reduced in purity by 3 per cent. by reason of the sirup that it takes up, but as its subsequent mixture with a rich sirup of nearly 100 test coming from the steam wash restores it to its original purity, it is clear that this sirup or molasses ought to be sent directly to the pan to be boiled into grain sugar and worked as usual. In the same way this sirup might be employed again as a wash if needed.

In *resume*, 100 kilos. of raw sugar of 95 test, with adhering molasses of 72 per cent. purity, contains 87·19 per cent. of crystallizable sugar and 12·81 per cent. of molasses. By the new process the first operation gives sugars of 98 per cent. polarization.

As 98 per cent. sugar contains about 5·13 per cent. of molasses, there is eliminated by this first operation with the molasses or sirup used in the mixture 12·81—5·13 = 7·68 per cent. of molasses per 100 kilos. of raw sugar. By washing with a sugar or sirup wash subsequently, almost all of the molasses remaining is eliminated, that is to say, 5 per cent. or less of the 5·13, and there remains adhering to the crystals in the centrifugals but 0·13 per cent. of sirup, or 87·19 + 0·13 = 87·32 per cent. of sugar, polarizing at least 99·8.

The washing with steam dissolves about 1 to 1½ per cent. of sugar. There remains then 86·5 per cent. of pure sugar for consumption in the first jet, which represents about 99·2 per cent. of pure sugar contained in the raw sugar. The sugar dissolved by the steam wash is not, as might be thought, lost, for it is secured in the next boiling of the molasses from the centrifugals under the form of raw sugar, which is again with fresh sugar reworked into sugar for consumption.

Thus with the new process there is obtained on the one hand all of the crystallized raw sugar in the form of sugar fit for consumption. On the other hand there remains but a single residuary product, the molasses, which is always maintained at its original purity, it being expected that it shall be separated at the end of the work and not permitted to enter into combination with the sirup or molasses used for the wash, nor with the sugar dissolved by the steam wash.

This new process of refining raw sugar is, as may be seen, of extreme simplicity. It requires no special outfit, excepting perhaps a slight addition to the centrifugals, and it insures a high yield in sugar, white and dry and fit for consumption.

According to our information, the results recently obtained at the Lebus factory by this process were very favorable. This factory has worked its low products two-thirds second jet and one-third third jet, making granulated sugars without employing bone black, and the granulated that they obtained by this method of work is of very handsome quality, if we may judge by the samples that have been sent to us.

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AN expert electrician asserts that an electric train making 125 miles an hour would require 7,000 feet in which to come to a standstill.

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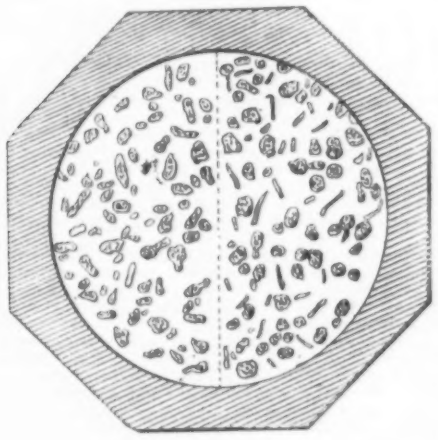
* Translated for *The Louisiana Planter* from *Le Journal des Fabricants de Sucre.*

## THE PRESERVATION OF BEER BY PASTEURIZATION.

THE preservation of beer in an unaltered condition depends chiefly upon the death or removal of obnoxious germs. After the first or stormy fermentation of the wort, it becomes quiet and is allowed to remain in that condition for several months, or until it is wanted for the market. The yeast and other germs, while the liquid is in this quiet state, gradually settle to the bottom and the liquid becomes clear, the clarified condition being also, in part, the result of the use of finings, of which diluted gelatine is a type. When the beer is in condition for the market, a quantity is drawn off and set with "kraeusen," or young beer, which has not yet completed the first fermentation. The effect of this is to generate in the mixture a limited quantity of carbon dioxide, and to this gas is attributable the life and sparkle of the commercial beverage. After this stage has been reached, the beer can be kept in good condition but a short time, especially in warm weather, or when subject to much agitation. It is this which prevents the shipment of beer to any very great distance, unless it is treated with some antiseptic process or composition. The untreated beer is subject to acetous and putrefactive fermentations, the results of which are, of course, very disagreeable to the palate and harmful to the health of the consumer. These harmful ferments are generally dormant during the first fermentation and during the subsequent quiet state, the conditions of temperature and surroundings being then inimical to their development, although, unfortunately, not fatal to their existence. These diseased ferments may also be acquired from the surrounding atmosphere.

The destruction of these germs is, therefore, necessary to the maintenance of the beverage in an unchangeable condition. This may be effected by the use of antiseptics, but antiseptics are generally poisonous, and even when not so, are likely to give a foreign and disagreeable taste to the beverage. This objection has led to the employment of heat in a manner analogous to its use in the preservation of fruits and meats in canning, and called from the name of the man who first explained its rationale, "pasteurization." Pasteur contemplated the extinction of obnoxious germs in two ways. The first of these consisted in the propagation of only pure yeast germs under conditions which are favorable to their development and prejudicial to the growth of others. The figure below is taken from his United States patent, No. 141,072, July 22, 1873, and shows in the left half only pure yeast germs, enlarged, while in the right half filiform ferments are also to be seen. These, in the presence of the alcohol generated by the pure yeast, and at the comparatively low temperature, about 50° F., fail to grow, and successive sowings of the pure yeast will eventually result in a product in which they will be so scarce that a portion may be found in which the microscope fails to reveal the presence of any.

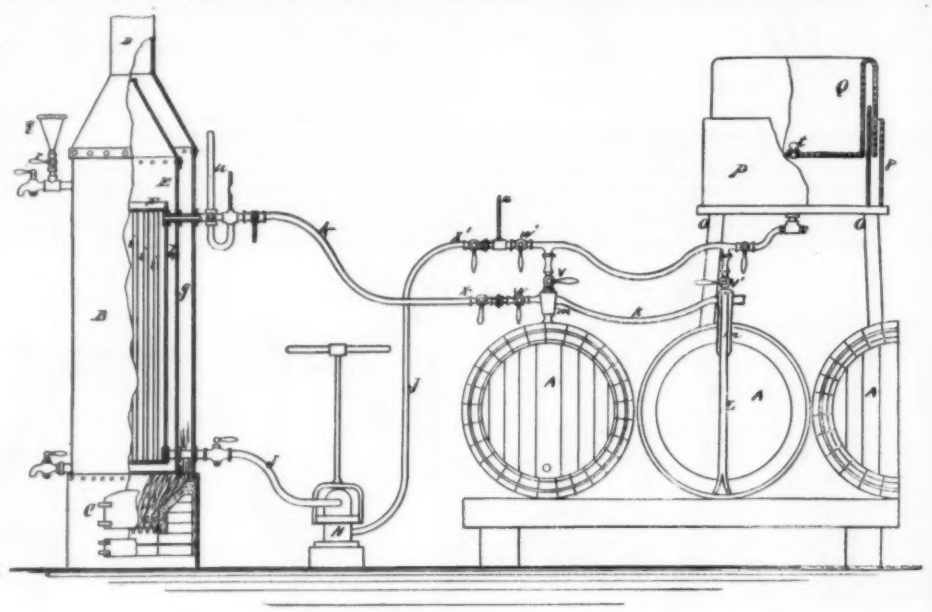


PASTEUR.

Wort treated with such yeast produces, of course, only pure beer, and if this beer be preserved from contamination by impure air or other impurities, will remain unchanged for an indefinite period. This is, however, in practice attended with many difficulties, and some means must be employed if the beer is to be kept for a long time to get rid of the contagion which almost inevitably creeps in. Heat is, all things considered, probably the most efficient and harmless germicide. Pasteur, in the patent mentioned, describes its application to the wort before it undergoes fermentation with pure yeast.

The warming of wines for the purpose of preserving them was probably first suggested by M. Vergnette de la Motte, but the rational explanation of the process was first made by Pasteur, it is believed. He first suggested the heating of wine to a temperature of 50° to 60° C. (131° to 140° F.), for a moment. The death of the germs at this comparatively low temperature he attributed, in part, to the presence of 8 to 10 per cent. of alcohol. Experiments upon bottled beer in 1871-2, by the same scientist, disclosed the fact that beer heated to 55° C. was sound, and still in a state of fermentation after the lapse of several months. Bottles not heated, and otherwise exposed to the same conditions, had become changed and were in some instances undrinkable. A temperature slightly higher—about 60° C.—is sufficient to kill the yeast germs as well as the filiform ferments, and to render the beer, when kept from contamination, absolutely unchangeable. Heating, however, especially when carried to a temperature slightly above that mentioned, is attended, especially when beer is treated, with results which are in other respects not so desirable. The delicacy of the flavor, especially of beer manufactured by the ordinary process, is apt to be affected, an effect probably attributable to the change effected in the albuminous constituents. Again, unless the beer is kept hermetically sealed and under strong pressure, the carbon dioxide is liable to escape, and must be restored artificially. This also tends to render the beverage less acceptable to critical palates. There is also great danger in coagulating some of the albuminoids present, and while this is a result sometimes sought after, it removes from the beverage a part of its nourishing properties. This is especially true if the temperature is raised much above 60° C. A difference of very few degrees at this point is sufficient to throw down a very decided precipitate of these materials. Another subject of anxiety is the danger of unequally heating different portions of the liquid and thereby producing variations in the taste, if overheated, and if not heated sufficiently, the danger of subsequent fermentation and ruin of the product. It is easy to see that the escape of any portion of the liquid with its germs still living would enable the contaminating influences to spread quickly to every part of the liquid. The patented devices hereafter described are all designed to overcome one or more of the objections pointed out above.

The first device for this purpose, patented in the United States and probably elsewhere, is that of Luquet & Huerne, No. 126,722, May 14, 1872, and is designed to carry out Pasteur's process in the treatment of wines. It is shown in the accompanying figure. The operation is as follows:

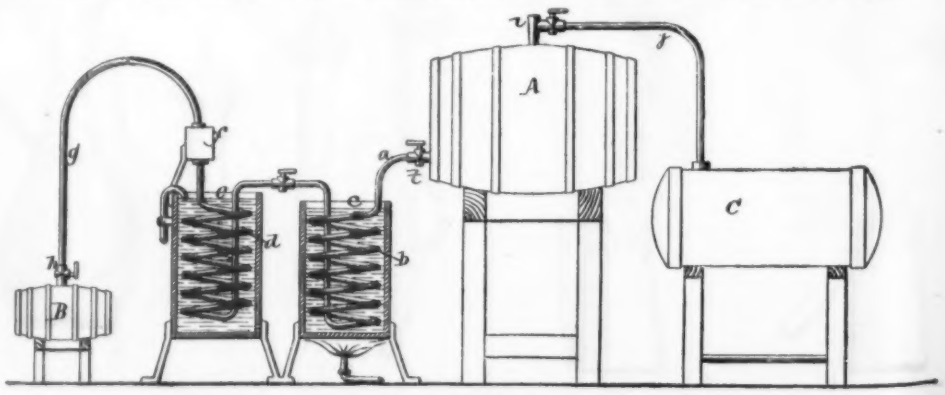


LUQUET AND HUERNE.

After arranging the apparatus, water space, *h*, is filled through the funnel, *q*, and the stopcock, *r*, below the funnel closed, and all of the remaining cocks in the pipes, J and K, opened. Wine or other liquor of the same quality as that in the cask is poured into the vessel, Q, until the heater, F, and pipes, J and K, are filled with wine, the proper instant to cease filling being indicated by the appearance of the liquid, seen through the opening in the bottom of the vessel, Q. The pump, N, is then operated until the air is exhausted from every part of the apparatus, and the plug, *t*, is then replaced. The fires under the heater are then lighted and the apparatus allowed to stand until the thermometer, U, on the pipe, K, indicates the required temperature, which will be about fifty (50°) deg. Centigrade or one hundred and thirty-five (135°) deg. Fahrenheit. The pump, N, is then worked until the thermometer, U', on the pipe, J, indicates the same temperature. By this means the wine is drawn from the bottom of the cask, through the pipes, L and J, into the pump, and thence forced into the heater and back through the pipe, K, discharging from the annular space between the pipe, L, and outer tube, *m*, the process being continued until both thermometers indicate the required degree of heat to destroy the organism in the wine. The expansion of the wine during the heating process will lift the vessel, Q, in the expansion tank, but the surrounding water joint will prevent the entrance of air into the tank. When all of the wine in the first cask has been thus heated, the cock, V, is closed, and communication can be opened through the cock, V', with the second barrel or cask, which will be treated in the same manner, and so on through the entire number of the set, after which the cocks, W and W', are closed so as to shut off the communication between the casks and heater. The pipes, J and K, can then be uncoupled at X, X', and transferred to another set of casks, arranged as above described, for repeating the same process upon another set of casks. In order to allow the wine in the casks already treated to cool, the cocks, V and V', can be opened so that the wine, as it cools, can gradually settle back into the cask from the expansion tank in proportion to the cooling of the contents. The tubes, L, L, are then removed and the casks closed up in the usual manner.

Luquet, in another patent, No. 136,741, March 11, 1873, discloses the idea of making the liquid which escapes after heating give up its heat to the incoming liquid. This is done by means of two concentric tubes, through the inner one of which the liquid enters.

The foregoing were especially adapted for the treatment of wine. The first patent for an apparatus especially adapted for the treatment of beer is that of Frash, No. 220,368, October 7, 1879, and shown here. The liquid is forced from the cask, A, by the pressure of the carbon dioxide in the tank, C, through the heating coil, *b*, which is immersed in hot water, then through the cooling coil, *d*, which is immersed in cold water, through the filter, *f*, which removes all impurities and coagulum, to the shipping cask, B. The gas serves to impregnate the beer as well as to force it through the apparatus. There are several other devices for forcing a liquid through a heating chamber, none of which are essentially different from this.



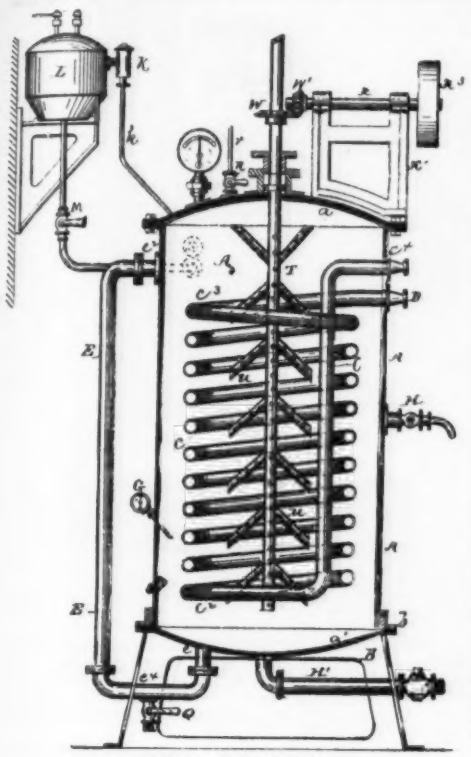
C. G. FRASH.

The next device in point of time to call for attention is that of Schaarwachter, No. 388,153, August 21, 1888. In this, the beer is introduced into the receptacle, A, and heated therein by a heating coil, C. E E are tubes through which the beer will circulate during the process. This circulation may be aided when necessary by carbonic acid gas introduced at R. As the vessel, A, is always filled absolutely full before the commencement of the process, a vessel, L, must be provided for the escape of the liquid as it expands with the heat. It escapes through the safety valve, K, into the vessel, L, and is allowed to flow back as the liquid cools, through the cock, M. The part, T, *u*, W and W', is a steam cleansing appratus.

Patent to Kuhn, No. 418,872, January 7, 1890. This patentee employs a very low temperature, degree not specified, to coagulate some of the albuminous matters present in the liquid. These are filtered out and the temperature raised as rapidly as possible to the required degree and reduced as quickly as possible thereafter to a normal one. The following is a brief description of the operation of the apparatus:

The arrangement is designed to effect a continuous and uninterrupted treatment of the beer while still kept in close vessels and without loss of gas. It is composed of three vessels, G, G', G" (the vessel, G", on account of the small size of the sheet, being shown above instead of in its correct position at the right of the vessel, G'), and each vesssel is preceded by a coil, *g*, *g'*, *g"*, respectively, through which the beer passes. Between the tun, *s*, and the first coil, *g*, is a pump, *h*, and pumps, *h'*, *h"*, respectively, are placed between each vessel, G, G', and the succeeding coil, *g'*, *g"*, and there is also a pump, *h'''*, between the vessel, G", and the shipping kegs. The same shaft, *k*, operates the four pumps. The pump, *h*, withdraws the beer from the tun, *s*, and forces it through the coil, *g*, which is immersed in water heated to the desired temperature of pasteurization. The beer is thus raised in tempera-

ture and is forced into the close vessel, G, whence the pasteurization is completed by the circulation of warm water in the coil, F, and jacket, L. From the vessel, G, the beer is withdrawn by the pump, $h'$, and forced through the coil, $g'$, immersed in cold water, and thence into the vessel, G', wherein it is further cooled while still



H. SCHAARWACHTER.

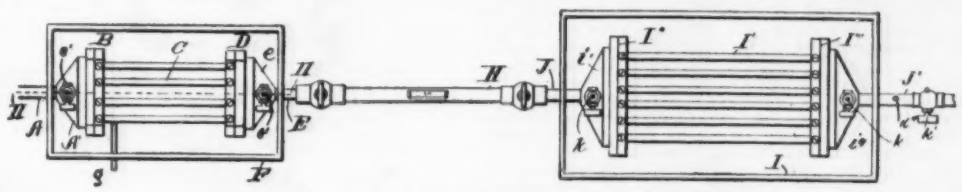
under pressure, by a circulation of cold water through the coil, F', and jacket, L'. From the vessel, G', the partially cooled beer is forced by the pump, $h''$, through the coil, $g''$, and vessel, G'', wherein, by the uncongealable liquid of an ice machine, it is reduced to its normal temperature and pressure, and thence transferred to the shipping kegs or casks by the fourth pump, $h'''$. As shown, there are three reservoirs, $r$, $r'$, $r''$. In the reservoir, $r$, water is heated to the pasteurization temperature by a steam coil. The reservoir, $r'$, is for ordinary cold water, and in the reservoir, $r''$, an uncongealable liquid is cooled by a coil forming part of the circulation of an ice machine. Before it enters the coil, $g$, the beer from the tun, $s$, passes through freezing coil, $C^*$, and a filter, $F^*$. In advance of each pump is a safety valve and pipe, V', for conducting any liquid which may pass the valve into a suitable receptacle. Thus any difference in the delivery of the different pumps may be equalized. With this apparatus the beer flows continuously, yet is kept always under pressure in close vessels, because the valve of one pump is always closed when that of the preceding or the following one is open, and the escape of carbonic acid is prevented.

In all the arrangements the beer which escapes past the safety valve or valves is or may be conducted by the pipe or pipes, V', to a small hermetically closed reservoir, whence it can be returned to the apparatus by means of a superior pressure of carbonic acid without any exposure to the outside atmosphere.

The last patent granted by the United States Patent Office for an invention in this art is that to Kersenbrock, 480,928, Aug. 16, 1892. It presents a somewhat novel form of apparatus by means of which the liquid can be rapidly heated and as quickly cooled.

The process carried on in the heater is as follows: Beer is conducted into the pipe, A, from whence it spreads into flared portion, A', and enters the pipes, C, through which it is forced through flared portion, $e$, here contracting again and entering pipe, E. When beer enters the series of pipes, C, from the left, steam enters the series of perforated pipes, G, lying underneath pipes, C, from the side, at the same time heating the water in the vat and keeping the same at the necessary degree of heat. In this connection it will be observed that the parallel pipes, C, are arranged in a horizontal plane, and being each directly above the pipes, G, with no intervening obstructions, they will be thoroughly and uniformly heated throughout.

Connecting the heating and the cooling apparatus is a pipe, H, having couplings, $h$, at each end provided



KERSENBROCK.

with turning cocks, $h'$. In the middle of pipe, H, is a thermometer, H', mounted in a frame, H'', the bulb of which is received by a socket piece, $h^2$. The purpose of this thermometer is to ascertain the degree of heat of the beer passing through the pipe.

The cooling apparatus is constructed similarly to the heating apparatus, without the steam appliances, and consists of a vat, I, a series of spaced pipes, I', preferably six in number, heads I'' and I''' at the ends of said pipes, and flared portions, $i'$, $i''$, of the inlet and outlet pipes, J, J', respectively, which pass through the ends of the vat. A detailed description of said parts is not necessary, for the reason just stated.

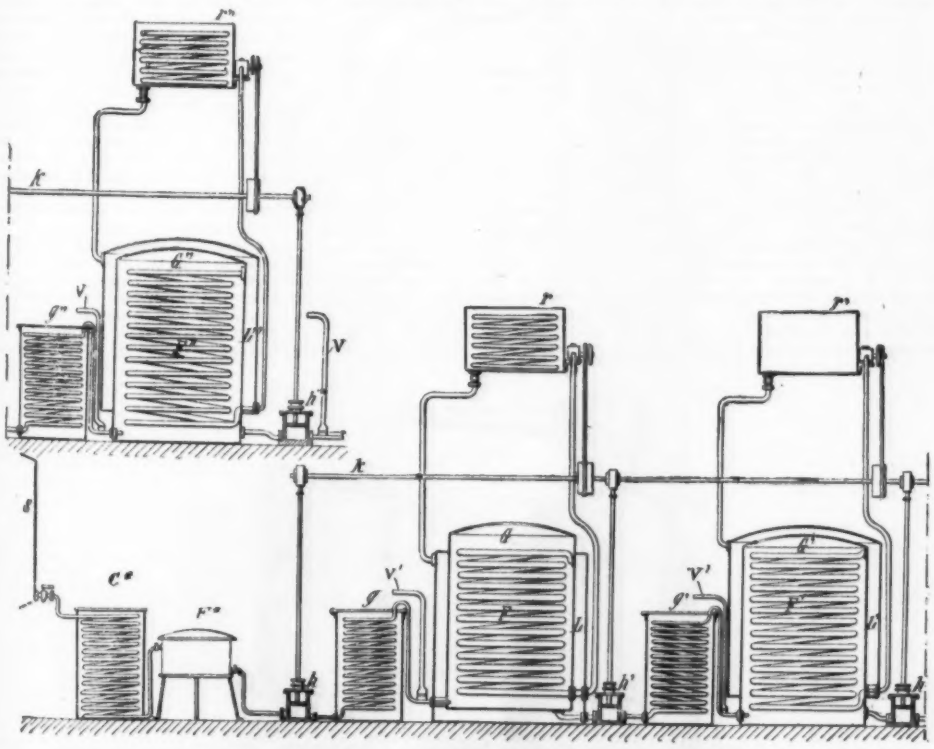
The foregoing devices, while they indicate the nature of the art, do not suffice to show its utility. Upon the proper execution of process depends the carrying property and consequent commercial value of most imported and exported beverages of the character indicated. The indications are that more developments will follow and that it will not be long before beer will be put up in bottles for indefinite preservation and under conditions which will cause it to improve, like wine, with age.

C. C. STAUFFER.

## NEW BRUSH FIBERS.

By JOHN R. JACKSON, A.L.S., Curator Museums, Royal Gardens, Kew.

THE wide extension, of late years, in the use of brooms and brushes in the streets of our large towns—in place of the old system of scraping—as well as at railway stations and other public buildings, has been the cause of a considerably increased demand for the material known as "bass" or "piassava," both from



KUHN.

Bahia and Para, and consequently of a considerable increase in the market value—so much so, indeed, that a large amount of attention has been given to the subject of substitutes, which has resulted in the adaptation of many inferior materials, and the introduction of some which, though similar in growth and structure, have been found unequal in strength and durability to true bass or piassava. The subject of brush-making fibers cannot be discussed without a reference to the name of Mr. Arthur Robottom, to whose exertions the introduction of piassava to the English brush-making trade is due, and who at the present time is still the practical authority on the subject. Writing in the *British Quarterly Trade Review* for June last, Mr. Robottom points out the great increase in the value of bass, which at its introduction realized from £6 to £9 per ton, and in the early part of 1891 had risen to £74 per ton, and this enormous price resulted, in the first instance, in the adaptation of a material known in the trade as "Bulah bass," which in fact is split bamboo, and was imported from Java and China. At first, it sold for about £50 to £60 per ton, a price which is said to have given the producers a large profit. Nearly 50,000 packages of this product have been received in England and on the Continent, but the price has now fallen to about £22 per ton.

It may be necessary to point out that true piassava, whether from Bahia or Para, is the coarse whalebone-like fiber of which the sheathing bases of the leaves of certain palms are built up, the Bahia kind being the produce of *Attalea funifera*, and the Para sort of *Leopoldinia piassaba*. One of the nearest approaches to these two substances is that which made its appearance from Madagascar a few years ago under the name of Madagascar piassava. The fiber, however, was much finer than true piassava, and, moreover, had none of its characteristics of strength and elasticity. It was not suitable to be used alone for ordinary brush making, but was generally mixed with the Bahia or Para kinds. Very little is known of the palm producing this fiber beyond the fact that it has received the provisional name of *Dictyosperma fibrosum*.

By far the most important substitute for real bass which has been brought to notice is that which has come to be known as West African bass or lagos piassava, which is the produce of the African wine palm or bamboo palm (*Raphia vinifera*). This substance was first brought to notice some four or five years ago, and its development is due to the efforts of Sir Alfred Moloney, the late governor of Lagos, who in 1890 issued a minute on the subject, which was very widely circulated, appearing in the *Kew Bulletin* in January, 1891. In this minute African bass is described as a stiff, wiry fiber, varying in color from dark brown to light red, and dependent for its shades on duration of soaking. It is most readily obtained in lengths of from 3 ft. to 4 ft., beyond which length it is inconvenient to pack and difficult to procure without injury to the tree. In diameter it varies from 1-16 in. to 1-30 in.

The bamboo palm is perhaps the commonest tree in the swamps and lowlands which line the waterways of the colony. Dense thickets of these palms, traversed only by the palm wine gatherer or the bamboo cutter, push their way into the lagoons and extend over the flood grounds, and even to a distance of from fifteen to twenty miles up the river valleys into the interior. It is hardly possible to calculate the area occupied by these Raphia forests, but it may be accepted without doubt that they extend throughout the length of the colony, and to a distance of at least fifteen miles from the sea coast, and that over this area of about 5,000 square miles they form a considerable proportion of the vegetation.

"When the 'bamboo' cutter clears away the leaves from the lower stem of the palms the trees present a very ragged and uneven appearance, owing to the practice of leaving a portion of the leaf stalk adhering to the parent stem. These base stalks partially inclose the bole of the tree and project upward and outward, forming the scaly covering which gives so strange an appearance to a grove of *Raphia* palms. From these stumps of the leaf stalks the native fishing lines are made. The fiber is extracted by a process of soaking and scraping which is exceedingly simple, and is fully understood by every 'bamboo' cutter and line maker. It is this fiber which is known in the European market as 'African bass,' and there is no apparent reason why with a population whose members are in the habit of preparing it, and a source of supply which may be regarded as practically unlimited, we [in Lagos] should not be able to compete on even terms with the sources of supply which at present monopolize the market." From these remarks it will be seen that African or Lagos bass is the fiber extracted from the petioles of the *Raphia vinifera*, and when properly cleaned and sorted it was valued at the close of the year 1890 at from £35 to £40 per ton. For some time good prices were maintained, and about the middle of last year it had gone up to £55 to £65; but the value has considerably decreased of late, the most recent quotations being from about £28 @ £40. The development of the fibrous bundles in the petioles of the *Raphia* palm for the purpose of brush making has naturally led to an examination of the petioles of other palms, and the latest introduction has been from Ceylon, in the form of a fiber prepared from the Palmyra palm (*Borassus flabelliformis*). It appears that quite recently a material known as "Bassine" has appeared in the English market. Its first appearance indeed was about the middle of last year, when the shipments realized from £36 to £42 per ton, which at the present time have declined to £22 to £33. The history of this brush fiber is given in the following extract from the Report of the Botanic Gardens, Ceylon, for 1891: "The sheathing leaf stalks of the palmyra, as of many other palms, contain a stiff thick fiber, and a new industry in the collection of this has sprung up under the auspices of a Colombo firm in the north of the island. These fibers or bristles are very much like the piassava, so largely exported from Brazil (the produce of the palms *Attalea funifera* and *Leopoldinia piassaba*) for brush making, and are doubtless exported hence for the same purpose. Immense numbers of the palmyra exist in the Jaffna peninsula and the islands near, and it is in the latter especially that the business of collecting the leaf stalks for sale has been carried on by the

inhabitants. In Elavaitivu the value thus collected in six months was about Rs.3,000, a great addition to the means of the people. Unfortunately, in their eagerness for this easy method of money-getting, they have treated the trees so badly that it is reported that in that island alone 1,000 young palmyras have been destroyed. As this palm is the principal permanent source of food in the country, and is besides of immense utility for timber, fences, etc., it became obviously necessary to put a stop to this reckless destruction, and steps, it appears, have been taken to regulate the fiber industry, which, properly conducted, should become a valuable addition to the means of living for the inhabitants."

In a note on this new brush fiber, dated June last, a firm of well known fiber brokers in London state that the chief objection to it by manufacturers is that it lacks straightness, but experiments are being made in this country to overcome this defect, and if they should prove successful it is expected that palmyra fiber will prove equal for wear to the best Brazilian piassava.

One of the most useful of brush fibers that has been largely developed of late years is that which is known as "Kittool" fiber, and, like those just referred to, is the produce of a palm—the *Caryota urens*, of Ceylon and Southern India. The palm is one of very great importance, furnishing a great variety of useful products. It is commonly known as the wine palm, in consequence of the quantity of "toddy" that is obtained from the spathe, which, upon being boiled, yields sugar or "jaggery;" the hard, dark colored wood is much used for building and for other useful purposes. The fiber, which is used for brush making, is deposited at the base of the leaf stalks, and completely surrounds the stem. In its natural state it is of a dark brown color, approaching to black; the fibers vary very much in thickness, and consequently in strength and elasticity. In Ceylon the finer fibers are used for fishing lines or for twisting into ropes, which are stronger and more durable than when kept dry. As used in this country for brooms and brushes, the fiber is selected so as to be, as far as possible, of a uniform thickness. It is then steeped in linseed oil to strengthen it and make it more elastic, when it becomes quite black. It makes a softer broom than bass or piassava, and is an excellent substitute for bristles. It has been largely used on railways and in large public offices, and the only objection to it from a manufacturer's point of view is that it lasts too long. The writer can testify to the great durability of Kittool fiber and to its power of retaining its shape and constituting a perfect sweeper. The finer qualities of the fiber, when steamed and curled, form an excellent substitute for horse hair for stuffing mattresses and cushions.

It is not a little remarkable that since the introduction of bass or piassava, some forty or more years ago, so very few substitutes of a similar character have been discovered, and specially so as the products that have been introduced are all furnished by the same natural order of plants—namely, the palms. Considering the nature of the palms, this, of course, would be expected; at the same time, in a family so large and so widely distributed in tropical countries as the palms are, and with the interest centered about new sources of supply, one might expect to hear of more frequent introductions. That there is room for a really good substitute for Brazilian bass every one will agree, and that this might be found in some of the very numerous species of palms that abound in the forests of South America might also be expected.

The success that attended Mr. Robottom's energy may any day be repeated by some fortunate traveler or resident in or near tropical forests.

## THE MANUFACTURE OF LIQUORS AND PRESERVES.

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

### PART I.—LIQUORS.

#### CHAPTER I.

IT is very difficult to define in an accurate manner the substances to which the term liquor has been applied, so numerous are the acceptations of this word; it designates certain chemical and pharmaceutical preparations as well as beverages. For the purposes of this work, let us consider liquors as *alcoholic beverages*, and under this title are included brandy, table liquors and aromatic wines.

We include natural liquors in the first class, which comprises alcoholic beverages prepared by simple distillation of the fermented juices of fruits. The preparation of brandy, kirsch, rum, and other liquors equally well known will be considered first. In the second class are included table liquors, or artificial liquors, as they are sometimes called, which includes beverages in which the base is alcohol or water, and only differ from each other by the presence or absence of sugar and in the nature of the aromatic substances, which are equally used by the perfumer and liquor manufacturer. In this class of liquors are included absinthe, anisette, curaçoa, etc. In the third class are included the aromatic wines, many of which were known to the ancients. In these wines the alcohol is not isolated, the base of the beverage being wine, or the juice of crushed grapes. Among wines of this class are included vermouth, hydromel, etc.

In addition to liquors proper, many articles, such as sirups and preserves, are manufactured, not only for direct consumption, but for use in the manufacture of the liquors themselves. Under this head will be included the preparation of simple and compound sirups, brandied fruits, *glacéd* fruit, etc.

The ancients had no knowledge of alcohol proper, which was only discovered in the thirteenth century, but they prepared aromatic wines, and the old manuscripts transmit a large number of receipts to us. The most ancient liquor of which we have any knowledge is hippocras, the invention of which is attributed to Hippocrates, the celebrated Greek physician; primarily, it is only an infusion of cinnamon in wine sweetened with honey, but with the change of fashion, this drink became more complicated and was served on all great occasions. This drink was given the place of honor during the middle ages, and it still figured among the refreshments served at the court of Louis XIV. and Louis XV. The Romans introduced various other liquors and aromatic wines, and in the middle ages people were equally addicted to their use. The discovery of alcohol made a revolution in the art of the *liquoriste*, and all the old receipts soon fell into oblivion. The wine of absinthe of Pliny only remains. We now call it vermouth.

#### CHAPTER II.

*Alcohol.*

Alcohol is the principal product of fermentation, particularly of glucose, and this includes nearly all the sugar confined in fruits. The transformation of this material into alcohol takes place with the development of a special ferment—alcoholic fermentation, of which one variety is that produced by brewer's yeast. The ferment is represented in Fig. 1. From a chemical

FIG. 1.—BREWER'S YEAST.

point of view, alcohol is a hydrocarbon; that is to say, composed of carbon and the elements of water—oxygen and hydrogen. It is represented chemically by the formula $C_2H_6O$. It is a limpid liquid, of a density of 0·7939 at a temperature of 150° (C.), when it is perfectly anhydrous, or, as it is termed, absolute. It boils under a pressure of 760 mm. at a temperature of 78·4° (C.) It has never been solidified, but it becomes viscous when exposed to the temperature produced by a mixture of ether, carbonic acid and snow. Its taste is burning and its odor is weak. It forms the active principle of all fermented beverages. It burns freely with blue flame, giving out much heat, but little light. Alcohol is mixed with water in all proportions, producing a slight warmth. Alcohol is a great solvent for a large number of substances, particularly for essences.

Alcohol was unknown before the twelfth century, in Europe. It is almost certain that the discovery of alcohol is due to the Arabs. We are indebted for this important discovery to a Frenchman, Arnauld de Villeneuve, born in Provence in 1740, who was a celebrated professor of the University of Montpellier. In his works he often speaks of alcohol. In 1813 Arnauld de Villeneuve died, leaving science a pupil worthy of him, Raymond Lulle or Lully. To this chemist is due, in the midst of an adventurous career, many important chemical discoveries in the process of extraction of alcohol, the most important of which was the method of concentration of the "spirit of the wine," which had before been very weak. He can be considered as the inventor of rectification. He wrote many treatises on alcohol, as did also Savonarola, J. B. Porta, J. R. Glauber, and others. In the eighteenth century alcohol became the base of medicines and of liquors for the table. The method of preparation became more scientific and alchemy gave place to chemistry.

*Section 1. Distillation.*—Distillation has for its object the separation of a volatile substance from other substances which are fixed at the highest temperature of ebullition of the volatile substance. For example, in the separation of alcohol from wine or other fermented drink, it is necessary to treat a mixture of alcohol, water and other substances. Alcohol boils under normal conditions at a temperature of 78·5° (C.) and water at 100° (C.) If now the mixture be heated to 78·5° and up to 100°, the alcohol will be volatilized and it can be obtained from the vapor by condensation. At 100° and over the water would begin to boil and give off vapor. The distilling apparatus is termed an alembic in its simplest form. In principle it is a flask which has a long neck communicating with an apparatus for condensing the vapor, usually by a vermicular tube or worm, as it is called. At the right temperature the vapor of the liquid is produced in large quantities and is condensed in the worm. The crude apparatus of J. B. Porta is illustrated in Fig. 2, in which G is the alembic, *t* the worm, C the condenser. Having now described the alembic in its simplest form, which is still frequently used in the laboratory for experimental purposes, we come to a modern still. It consists (Fig. 3) of a still consisting of the alembic and head, 4, connected with the worm, 6, by the swan's neck, 5. This apparatus has innumerable changes and improvements, the alembic in many cases being sunk in a water bath instead of being exposed to the naked fire.

The simple still, such as has just been described, does not permit, at the first distillation, of a liquid being condensed which is sufficiently strong in alcohol to be used directly by consumers. The product of the first distillation must now be subjected to a redistilla-

FIG. 2.—DISTILLING APPARATUS OF PORTA.

tion, which has for its object the elimination of water. This occasions a great loss of time and fuel. To obviate these difficulties, an apparatus called a wine heater was devised, which permits of alcohol being obtained sufficiently concentrated for some purposes at the first operation.

*I.—Distillation of Wine.*

*Apparatus of Adam.*—The first apparatus constructed to arrive at this object was that of Edouard Adam, who in 1800 thought of the application of the wash bottles of Woulf to distillation. This alembic permitted of the distillation of thirty hektoliters forty liters of wine in six hours.

The somewhat crude apparatus of Adam was modified in 1818 by Derosne, and since by Cail. It consists of two stills placed at different heights. These stills communicate with each other by a curved pipe, designed to carry the vapors of the first furnace to the second. Connected with the second still is a column or tube containing semicircular disks of unequal size placed one above another. In consequence of this arrangement the vapors ascending come in contact with large surfaces moistened with wine. Another rectifier is over this, and the vapors are finally condensed in a worm, the first spirals giving the highest per cent. of alcohol. The worm can be tapped at different points to obtain alcohol of all degrees of strength. The Laugier apparatus (Fig. 4) is on the same principle. It is composed of two stills, A and B, placed at different heights. The first, A, receives the direct heat of the naked fire, the second, B, is heated by the flame and gas of the fire. The vapors produced by the heating of the wine in A are condensed in the liquid of B, which is thus rendered more alcoholic. The operation in brief is as follows: The liquid intended for distillation flows from the reservoir, E, into the vessel. D, entering its lower part and serving to condense the alcoholic vapor. From this vessel the warm fluid passes by means of the tube, *r*, into the lower part of the vessel, C, which is heated by the hot gases evolved from the fire kept burning under the first still, A. In the still, B, the fluid undergoes a rectification, and the vinasse flows by the tube, S, into the first still, A. The hot vapor is carried by the pipe, *m*, from A to B; the tube, *p*, carries the alcoholic vapors into the dephlegmator. The tube, *q*, conveys the phlegma into the still, B. The tubes from C carry the vapors to the condenser, D. The system seems to be very economi-

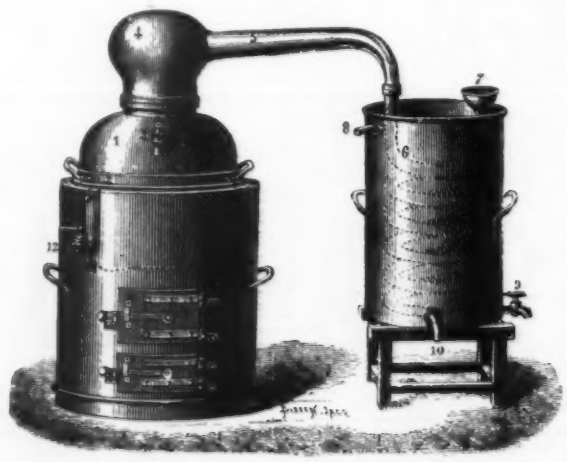


FIG. 3.—STILL OF DEROY FILS AINÉ.

cal, and is used with great success in the central part of France, where a considerable portion of the wine produced is used in manufacturing alcohol. A large number of forms of distilling apparatus have been constructed after those of Laugier. Disregarding the various modifications of this and other systems, let us proceed

directly to the consideration of the most modern forms of distilling apparatus. Different systems are employed. The ones more generally adopted are those of Deroy and Egrot.

The Deroy Sons apparatus (Fig. 5) consists of lenticular plates, numbered 4, superimposed on the still. The still (1) is charged by pouring wine in at funnel (11). The condenser (13) is filled with water, or if desired, with the wine which is to be operated upon. The still having been charged and started by the application of heat, a stream of water proportioned to the required strength of the alcohol descends from the plate (4) to plate (4) by the pipes 5 and goes out by the pipe, 6. The strength of the alcohol can be varied by the temperature which is maintained in the plates or cisterns, 4. The vapors pass up from the still and come in contact with the inner walls of the cisterns, which are kept cool. The vapors which have arrived at 8 expand and pass through the swan's neck, 9, into the wine heater, 12, which contains a worm, and from

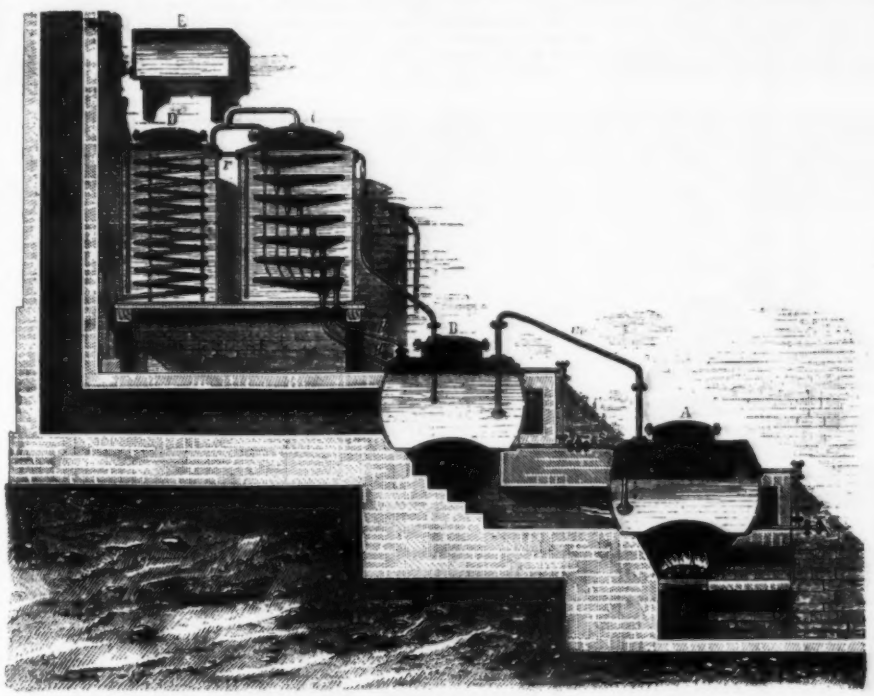


FIG. 4.—APPARATUS OF LAUGIER.

A, first still heated by the fire; B, second still heated by the vapor: C, dephlegmation vessel; D, condenser; E, reservoir.

thence to the condenser, 13, by the pipe, 18, where they are condensed in the worm and pass out to be tested by the hydrometer, 22. In this tortuous ascension the alcoholic vapors can be brought back to the still by the tube, 15. M. Deroy also makes a similar apparatus having four reservoirs or cisterns (Fig. 6). This suffices for wines which are weak in alcohol, but for wines which are rich in alcohol another cistern is necessary. The general arrangement is the same as in Fig. 5. The following description of the Egrot apparatus is taken from the SCIENTIFIC AMERICAN SUPPLEMENT, No. 448, as the description is given in more detail than in M. Brevans' book.

The continuous distilling apparatus of Mr. Egrot's invention are especially applicable to fermented liquids, molasses and wines. In devising them, the inventor's object has been to reduce the dimensions of the distilling column, and principally the height thereof, which, in ordinary apparatus, is considerable.

The result is a diminution in the purchase price and in the cost of installation and carriage. Such result has been obtained by increasing the length of the liquid's circulation in each shelf and by diminishing the number of shelves. In fact, there are but four or five of the latter in Egrot's column, while there are 18 in those of Dubrunfant and Champonnois, and as many as 32 in that of Savalle. From this diminution in the number of shelves or trays results a diminution of pressure in the column, and, consequently, more regularity in the work, a better product, and less priming. At the same time, the total surface being less, the external cooling is not so great.

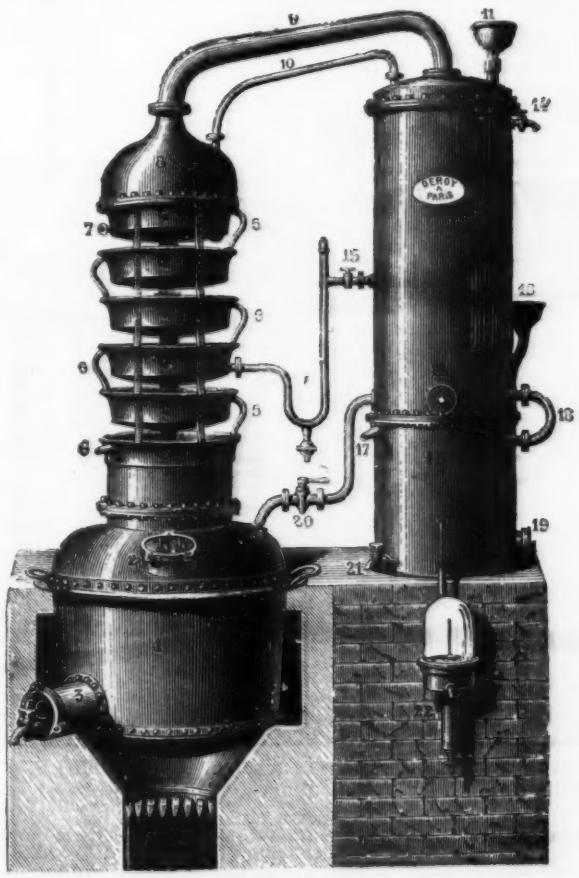



FIG. 5.—APPARATUS WITH LENTICULAR PLATES.

The Egrot distilling apparatus (Fig. 7) consists of an alembic, of a wine heater, and of a condenser. The alembic, M, is of small dimension as compared with the column which it serves to support. The distilling column, which is in five parts, supports another column

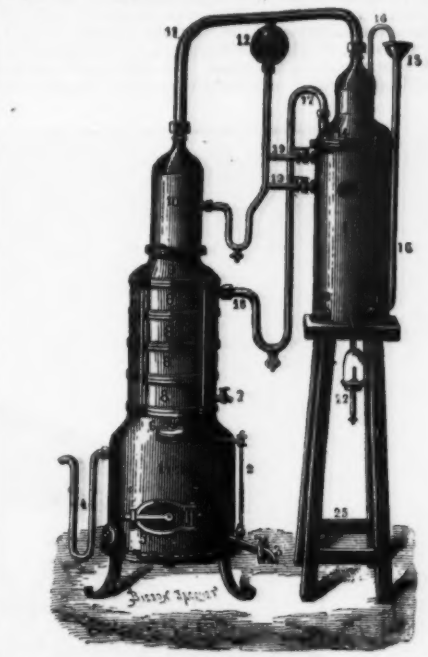


FIG. 6.—APPARATUS FOR CONTINUOUS DISTILLATION

of smaller diameter, which contains a certain number of rectifying shelves.

The wine heater and the condenser, which are both cylindrical, are traversed by a worm that terminates at the test apparatus. Fig. 8 gives the details of the arrangement of a shelf, and shows the course taken by the liquid, which, after entering at A, from the upper shelf, traverses four concentric rings arranged one

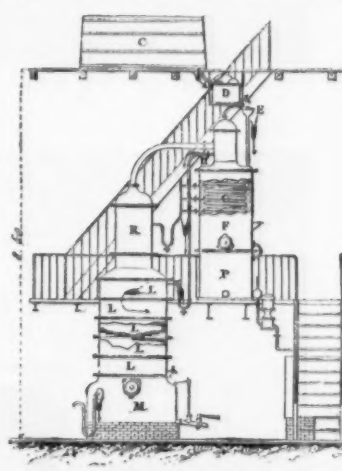


FIG. 7.—EGROT'S STATIONARY STILL.

under another, and makes its exit at E, in the center of the shelf, which latter is also the lowest point of its travel. From thence a bent tube leads it to the point, A, of the lower shelf. The apparatus, in another form, when mounted upon two wheels and drawn by a horse, is very transportable, and is capable of being set in operation immediately upon reaching its destination.

Each shelf or disk is provided with quite a number

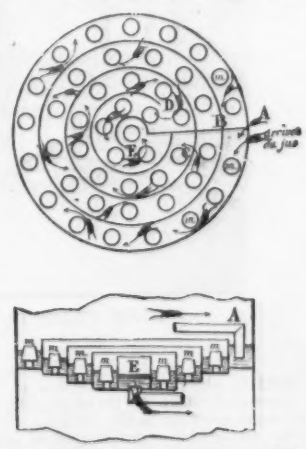


FIG. 8.—PLAN AND SECTION OF ONE OF THE RECTIFYING SHELVES.

of tubes, *m*, of small dimensions, which allow the alcoholic vapor coming from the alembic to bubble up through the liquid, and thus have numerous points of contact therewith. This arrangement likewise allows the liquid to travel a considerable distance within a

very short time. The apparatus represented (Fig. 7) is capable of treating 110 gallons per 24 hours.

It is easy to see how the still works. From the reservoir, C, the wine is introduced steadily into the wine heater, F, through the intermedium of the regulating cistern, D, where its level is kept constant. There is thus obtained a uniform discharge from the cock, E. The wine gradually rises in the heater, F, and becomes heated in contact with the worm, G, in which the alcoholic vapors are condensing. It afterward enters the distilling column, I., through the tube, H, and deled by a swan neck to the wine heater, where it is analyzed. The liquefied portions return to the column and the others condense in the cooler, P, and when they make their exit from the latter they go to the test tube.

There are fourteen sizes of these stills, that range in capacity from 88 to 220 gallons per 24 hours.

In certain cases, Mr. Egrot adds to his apparatus certain accessory arrangements for special purposes. Thus, in order to permit of the production of alcohols of a higher proof than those afforded by ordinary apparatus, he adds a rectifying head, which will give an alcohol exceeding 85°.

For the manufacture of cordials, the alcoholic vapors, before entering the condenser, are introduced into a special receptacle, called an "anising box," in which are arranged the aromatic materials, such as anise, absinthe, juniper, etc.

*(To be continued.)*

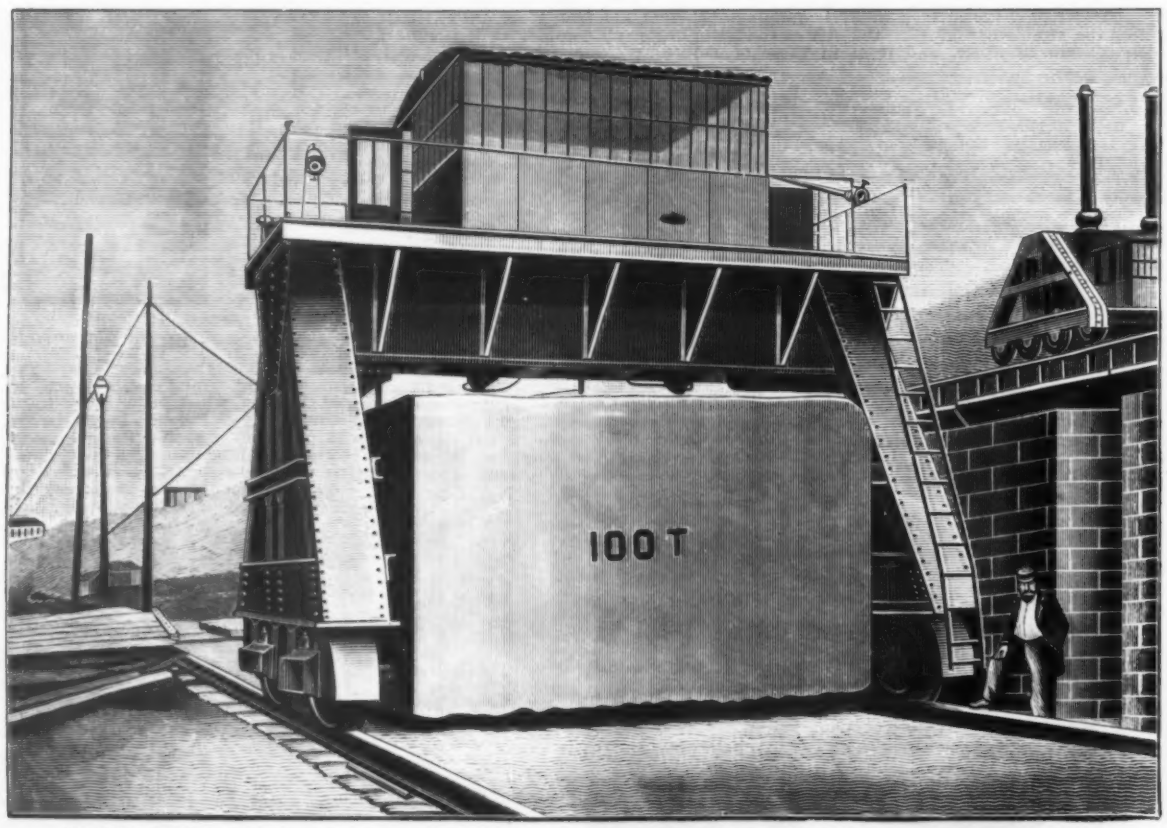
HOT water taken freely half an hour before bedtime is helpful in the case of constipation and has a most soothing effect upon the stomach.

## APPARATUS FOR MANUFACTURING AND LIFTING BLOCKS OF BETON AT THE PORT OF BILBAO.

As the method of manufacture of the blocks of beton used in the construction of an external port at Bilbao, and the apparatus employed for lifting and carrying them, present some novelty, we propose to enter into some detail upon the subject.

The beton apparatus, constructed by Carey & Lathan, an English firm, consists of a cylinder 3 meters

WORK AT THE PORT OF BILBAO—FRAMEWORK AND APPARATUS FOR LIFTING BLOCKS OF BETON AND LOADING THEM ON A BARGE.




FRONT VIEW OF THE APPARATUS FOR LIFTING BLOCKS OF BETON AND CARRYING THEM TO THE CAR.

scends from shelf to shelf, and, in doing so, becomes deprived of more and more of its alcohol by contact with the vapor that is rising in the column. When the wine reaches the alembic it is entirely freed from alcohol, and the *vinasse* that continuously flows through the siphon, S, contains not a trace thereof. The alcoholic vapor follows an opposite direction. From the alembic, M (heat by steam or otherwise), it rises and traverses each shelf, and becomes richer and richer in contact with the richer wine that it meets at every moment.

It afterward traverses the rectifying column, R, which contains a certain number of shelves, and is then

in length and 0·91 meter in internal diameter, movable around its axis, which makes an angle of about 3° with the horizontal. In the interior of this cylinder there operate sixteen helicoidal paddles fixed upon a tubular axis, which makes fifteen revolutions per minute, while the external cylinder makes twenty. Into the interior of the latter, two chains of buckets, through lateral hoppers, empty the stone and sand in the proper proportions. The cement is put into a hopper placed upon a covered platform, whence it is taken up by a screw and carried to the interior of the cylinder in which the beton is under preparation. The velocity of this screw is independent of the general

# APPARATUS FOR MANUFACTURING AND LIFTING BLOCKS OF BETON AT THE PORT OF BILBAO.

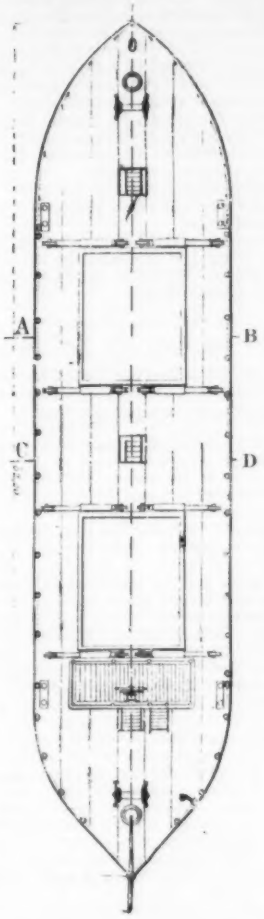



Fig. 1.

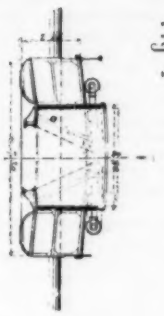


Fig. 7

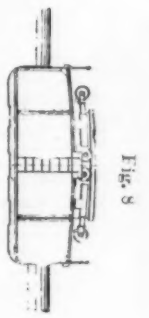


Fig. 8

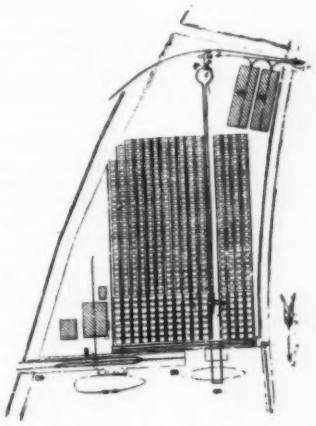


Fig. 9

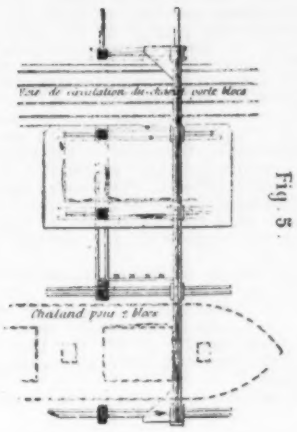



Fig. 5

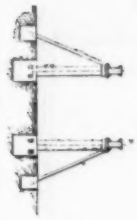


Fig. 6

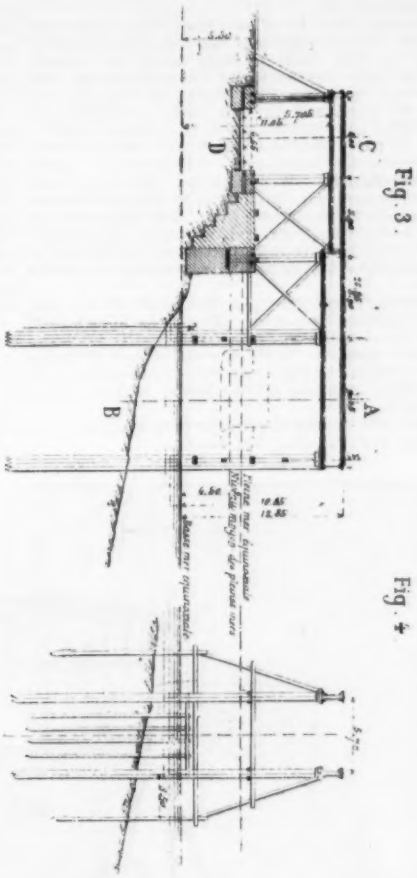



Fig. 3.



Fig. 4

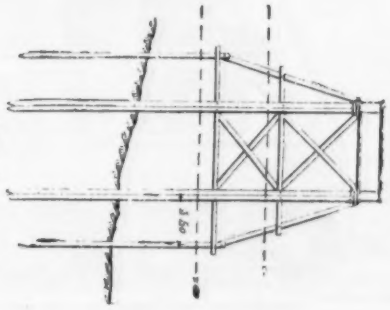


Fig. 2

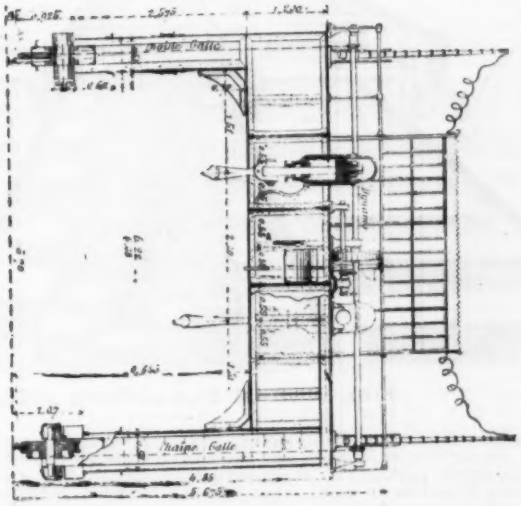



Fig 10

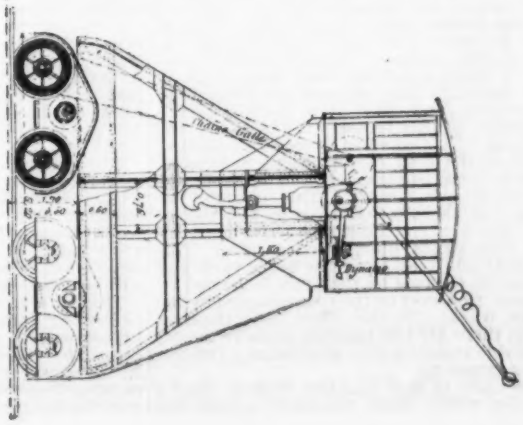



Fig. 1

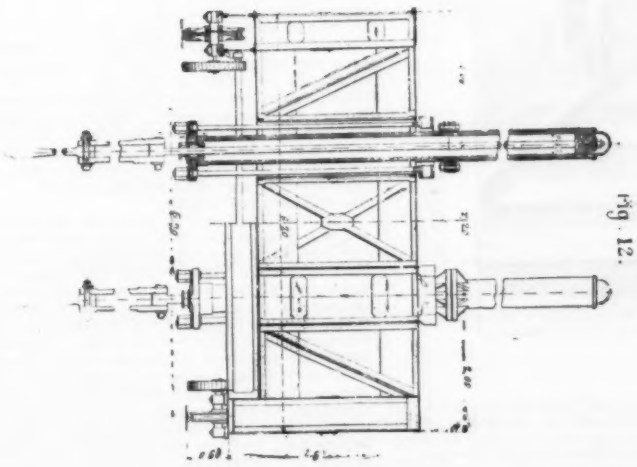


Fig. 12.

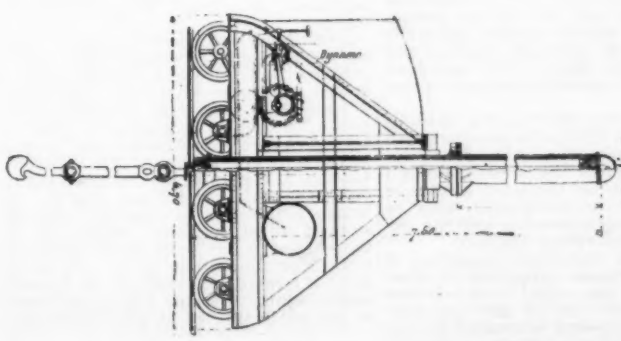


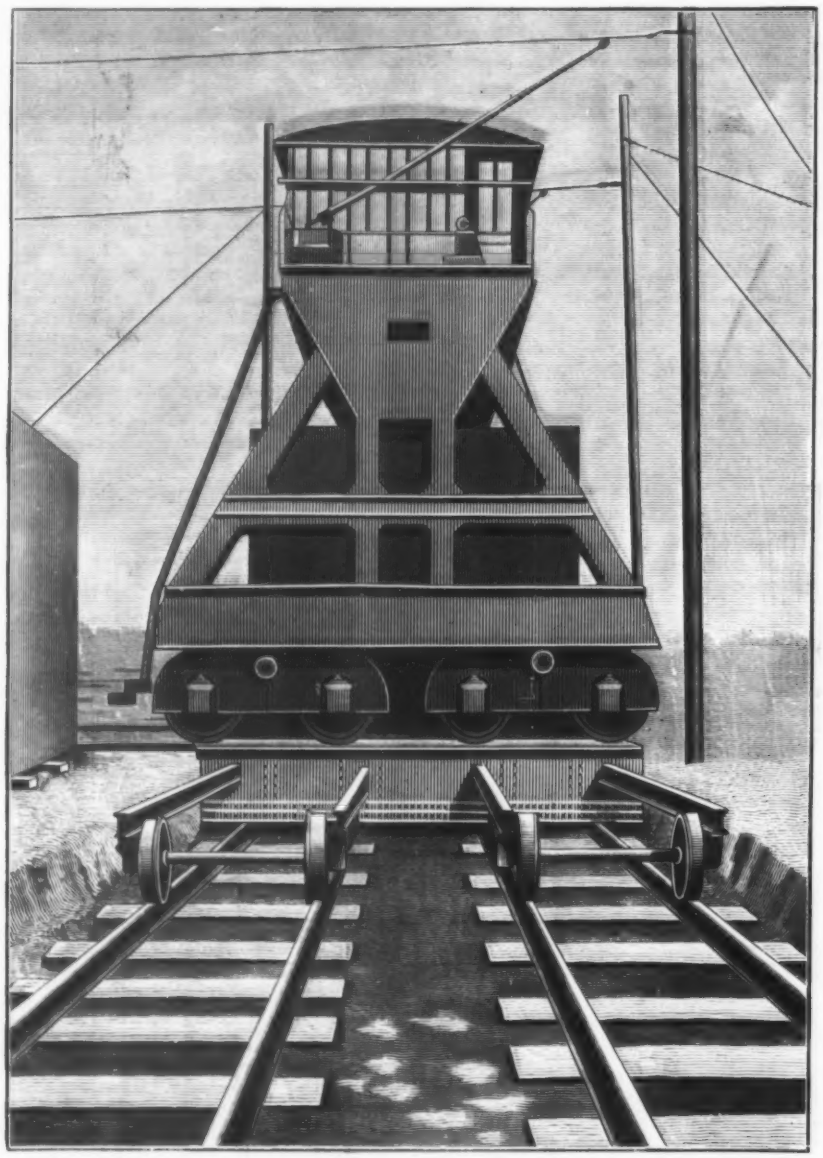

Fig. 13.

motion of the apparatus. It is so regulated that the quantity of cement that it introduces into the cylinder may be varied at will.

The materials, that is to say, the stone, sand, and cement, enter simultaneously at the top of the cylinder, and during the first third of their travel are mixed, while dry, through the motion of the paddles and that of the external cylinder. The water, the quantity of which can be regulated at will, enters continuously through a tube that debouches in the second third of the length of the cylinder, so that the elements that form the beton are intimately incorporated before leaving the apparatus. When finished, the beton falls into Decauville cars, which carry it to the spot where the blocks are to be manufactured. The apparatus is capable of furnishing from 15 to 18 cubic meters per hour, and this permits of manufacturing four blocks of 50 cubic meters or seven of 30. The power of the motor is 18 horses.

The contractors arrange upon the platform for preparing the blocks 517 moulds, 120 of which are of 50 cubic meters and 397 of 30, representing a total volume of 17,910 cubic meters. With the method of carrying that they employ, they are capable of submerging, in a period of three months, all the blocks that the platform can hold.

Let us now pass to the apparatus employed for lifting, carrying, and shipping the blocks.



SIDE VIEW OF THE LIFTING APPARATUS.

The frame of the rolling crane for lifting the blocks consists of two strong trestles of plate and angle iron connected at the upper part by two crosspieces that support a flooring 2·6 meters in width, upon which is installed the entire motive mechanism. The crane is provided with four pairs of wheels and runs upon tracks of 5·7 meters gauge, formed of Vignole rails supported by strong wooden ties. It differs but little, as a whole, from the cranes that have hitherto been constructed for the same purpose; but up to the present only manual or steam power has been used, while in this case it is electricity that actuates the lifting and shifting mechanisms and that gives motion to the various apparatus serving to carry the blocks to the place of shipment. To this effect there is installed at a certain point of the field of operations a dynamo actuated by a 60 horse power compound engine making 300 revolutions per minute. This dynamo develops an e. m. f. of 220 volts and produces a current of 200 amperes. The e. m. f. is transmitted by a non-insulated copper wire strung upon wooden poles. This conductor is established all along the beton yard, and the current may be received by the dynamo carried by the rolling crane, whatever be the spot occupied by the latter upon the tracks. To this effect, upon the sides of the platform there are two bamboo canes 3·6 meters in length, movable around a joint situated at 1·1 meters from the lower extremity.

At the upper part of each bamboo there is fixed a small iron pulley which bears constantly against the wires of the circuit, owing to a counterpoise at the base of the bamboo canes. Communication between these pulleys and the receiving dynamo is established by means of copper conductors covered with gutta percha. The circuit is closed through this dynamo. The current traverses a resistance apparatus which allows of the passage of the whole or a part of the e. m. f., according to the work to be effected.

The receiving dynamo makes 600 revolutions per minute, and effects the rotation of a horizontal shaft that transmits power either to the pistons of the hydraulic presses that serve to lift the blocks, and that have a maximum stroke of 0·4 meter, or to another horizontal shaft situated at right angles with the other, and upon which are mounted pinions that gear with two endless chains. The latter transmit the power to drums fixed to the front wheels of the crane. These wheels produce the motion of the entire apparatus upon the tracks at the velocity of 10 meters per minute.

The pistons of the hydraulic presses are connected by joints with the hooks that serve to suspend the blocks. The length of the hooks varies with the size of the blocks to be lifted. Each block carries two lewisons, that are set into the block at the time of its manufacture, and with which the suspension hooks engage.

When the apparatus is placed over the block to be lifted and carried, the hooks are introduced into the lewisons, then the machine is set in motion, and the suction pipe of the pump is opened, in order to allow water to enter the cylinders of the hydraulic presses. As soon as the pistons of the latter have lifted the block about 30 centimeters, the pipe is closed, and the wheels that control the motion of the crane upon the rails are thrown into gear. The crane, once in motion, is led over a truck or car that runs upon a transverse track. At this moment, the cylinders of the presses are emptied and the block slowly descends upon the platform of the truck. This operation finished, the hooks are disengaged and the crane moves backward over another block, which it carries to the truck as before.

The truck or car that carries the block is likewise moved by electricity. To this effect, it is provided with a receiving dynamo analogous to that of the lifting apparatus. This dynamo receives the current through copper wires. The latter are not insulated, so that at every point of their length communication may be established with the receiving apparatus and the circuit be closed through the generating dynamo.

This car is hauled under a framework consisting of two strong horizontal iron trusses supported by cross-braced wooden posts, each surmounted by a cast iron cap. The bases of these posts are set into masonry. At the upper part of the framework is situated the apparatus designed to lift the block and bring it directly over the lighter that is to carry it to the point where it is to be submerged. This apparatus is set in motion by electricity. It is constructed upon the same principles as the other lifting apparatus, but its frame is not of so large dimensions, and the stroke of the pistons of its hydraulic presses is different, being seven meters.

The pumps that send the water into the cylinders and the shifting mechanism receive their motion from the dynamo that the apparatus carries with it.

Referring to the diagram illustrations:

Fig. 1. Plan of artificial block works.
Fig. 2. Front elevation of dock.
Fig. 3. Longitudinal section of same.
Fig. 4. Transverse section of same.
Fig. 5. Plan of same.
Fig. 6. Transverse section through C, D, Fig. 3.
Figs. 7, 8, 9. Float for transporting the blocks.
Figs. 10, 11, 12, 13. Wheeled apparatus for moving the blocks.—*Le Genie Civil.*

## FLOATING BRIDGE AT PORTSMOUTH.*

### DESCRIPTION OF THE NEW FLOATING BRIDGE BETWEEN PORTSMOUTH AND GOSPORT.

By Mr. H. GRAHAM HARRIS.

*Crossing Rivers.*—Many arrangements have been devised for crossing rivers or arms of the sea in those positions where it is necessary not only to facilitate the crossing, but also to keep the waterway open, so as to allow of the passage of large ships.

*Opening Bridges.*—One of the most notable of these, at present in course of construction, is the Tower Bridge over the Thames in London. Here a very heavy expenditure will be incurred to build a bridge connecting the north and south sides of the river between the Tower on the one side and Horselydown on the other. Fig. 1 is a diagrammatic elevation of the bridge, showing the means which have been adopted for keeping the waterway open for vessels with lofty masts, while still maintaining a possibility of traffic from side to side of the river. The central span, which is 200 ft. in width, is an opening span; that is to say, the halves of the span can be lifted, being hinged on the piers at their inner ends, so as to leave the span clear. These piers are carried upward, and at a clear height of 135 ft. above ordinary high water are connected by a fixed bridge for foot traffic, enabling that traffic to be carried on even when the central span is open for the passage of large vessels. The piers are provided with staircases and with hydraulic lifts, the opening and closing of the central span being also performed hydraulically.

*Ferries.*—Another mode of obtaining the above end is that adopted in the case of the Thames ferries at Blackwall, or in the Birkenhead ferries for crossing the Mersey between Liverpool and Birkenhead. In these cases there are one or more steamers, which ply from side to side, not being confined, however, to one particular line of course; being, therefore, affected by wind and tide, and requiring to be navigated, also requiring considerable power in the engines to enable these to propel the vessel at a sufficient speed to give steerage way when contending with strong tides and winds. With ferries the difficulties of difference of level between the vessel and the shore, due to rise and fall of the tide, have to be provided for; this is usually done by a floating landing stage connected to the shore by a hinged prow or gangway.

*Tunnels, etc.*—A tunnel is of course an obvious mode of enabling a crossing to be made while maintaining the waterway open. Notable instances of such tunnels in Great Britain are the Severn Tunnel, the Mersey Tunnel, between Liverpool and Birkenhead, and the new tunnel between Glasgow and Govan. With tunnels, as with a high level bridge, the great difficulty which has invariably to be surmounted is that of the approaches. In order to allow of a workable incline for these, if the water to be crossed is deep and the tunnel level consequently some distance below the surface, the approaches must be of great length, or else hydraulic or other power lifts must be resorted to. Similar troubles arise with a high level bridge. In the Mersey tunnel the traffic, which is a passenger traffic, is taken up and down by hydraulic lifts, thus avoiding any length of approach. In the new tunnel in Glasgow hydraulic lifts will also be used, and will there be employed to deal with wheeled traffic, as well as with the ordinary foot traffic.

*Floating Bridge.*—No mode of attaining the desired end is so cheap, not only in first cost but also in working, and none is so satisfactory in many respects, as a floating bridge. Such a structure consists of a barge or vessel, which has passing through it one or more chains, supported on chain wheels, which are carried on the barge and are capable of revolution by power of some kind, carried by the bridge itself. The chains are laid from side to side of the water which has to be crossed, their ends being anchored on the shores; and the crossing is effected by the bridge hauling itself in either direction from one side to the other, lifting up the chains from the bottom, passing them through the bridge and over the chain wheels and dropping them behind as it advances. The barge or vessel is made very shallow, so that it can approach close to the shore; and it carries at each end a projecting prow or landing stage, which has its inner end hinged upon the bridge, while the outer end is capable of being raised or lowered by power carried within the bridge.

*Advantages and Disadvantages.*—It will be seen that the result of such an arrangement as this is that with ordinary foot or wheeled traffic very little difficulty, indeed, is experienced with the approaches, nor are the differences of level tide ordinarily of serious importance. Further, in its passage to and fro the bridge keeps to a regular and fixed course, no matter what may be the state of the wind or tide. This is of great advantage to the traffic up and down the river, or in and out of the harbor, as the case may be. In addition the bridge requires no navigating, and can be readily stopped at any moment, being held or anchored by the chains in any position in which it is brought to rest. Most important of all, the power required to move it is small, and need not be in excess of that ordinarily required, because a structure worked in this way is not much affected by winds or by currents. These,

* Paper read before the Institution of Mechanical Engineers.—*Engineering.*

then, are the advantages to be claimed for a floating bridge. The disadvantage, which is a very serious one, is common also to steam ferries, or to any mode of crossing other than that by a fixed bridge. It is that any traffic desiring to cross, which arrives at the bridge end just after the bridge has started for the other side, has to wait until the bridge has crossed and has returned before it can continue its journey. This is a disadvantage which has been felt between Portsmouth and Gosport, and has affected the communication there.

*Torpoint Floating Bridge.*—The Torpoint Bridge at Devonport was designed by the late Mr. James Meadows Rendel, and was put to work in the year 1834. A sectional elevation of this is shown in Fig. 2. It is built of wood, and is roughly 55 ft. in length and 45 ft. in width, with a draught of water when fully loaded of 2 ft. 6 in. The engine was a condensing beam engine, with cylinder 19 in. in diameter and 30 in. stroke, the revolutions being 35 per minute, and the boiler pressure 3½ lb. per sq. in.

*Nile Floating Bridge.*—Over the Nile, about midway between Alexandria and Cairo, there is a form of floating bridge for conveying railway trains across the river (Fig. 3). This was designed by Mr. Robert Stephenson, and was erected and put to work in 1857. It consists of a flat-bottomed barge of shallow draught, carrying a vertical iron structure, in which is a platform extending the whole length of the barge, and sufficiently wide to carry two lines of rails of the ordinary gauge. The platform is capable of being raised and lowered in the iron structure which supports it. An allowance of 27 ft. between high and low Nile during the year has to be provided for. This variation occurs at the rate of about a few inches per day, and the platform is daily adjusted to the requisite height in the structure. The nicer adjustment required for transferring the railway carriages from the barge rails to those of the timber jetties on each side of the river is made by short lengths of hinged rails. The bridge is moved from side to side of the river by engines carried in the bridge, in a manner similar to that in which the Torpoint Bridge is moved and similar to that in which the floating bridge forming the subject of this paper is moved.

*St. Malo Traversing Bridge.*—In Fig. 4 is illustrated another method of crossing a tideway, by means of a traversing bridge, as employed across the harbor entrance between St. Malo and St. Servan. The distance to be traversed is about 110 yards, the spring tides here rising to a height of 34 ft., though at low water of these tides the passage is dry for some hours. The bridge consists of a platform supported from the bottom of the harbor at a height of 36 ft. on four wrought iron braced columns. These columns rise from a framework carried on four wheels, which run on rails laid on the bed of the harbor. Motive power is supplied to the bridge by means of hauling chains laid along the bottom, which are worked by a winding engine on the St. Servan side, thus hauling the bridge backward and forward.

*Portsmouth Floating Bridge.*—Prior to the year 1840 the connection between Portsmouth and Gosport, then towns of considerable size—the population of Portsmouth being 50,000, and of Gosport, including Alverstoke, upward of 14,000—was by means of the historical wherry. All readers of Marryat remember the Portsmouth wherry, which was practically similar to the boats now plying in the harbor and used by the watermen. It is an extremely useful and handy boat for the purposes for which it is intended.

An iron floating bridge to ply between the beach at Gosport and the point at Portsmouth was designed by Mr. Rendel, and was put to work on May 4, 1840. This bridge was practically similar in principle to the one at Torpoint, and practically similar to the new one which was only launched on the 13th of October, which has since been towed round from the yard of the builders, Messrs. Allsup, of Preston, and which it is hoped the members will visit.

*New Floating Bridge.*—Except in small details, the new floating bridge is so much like the original bridge that a description of the new one will be all that it is necessary to give. The new bridge is shown in Figs. 5, 6 and 7.

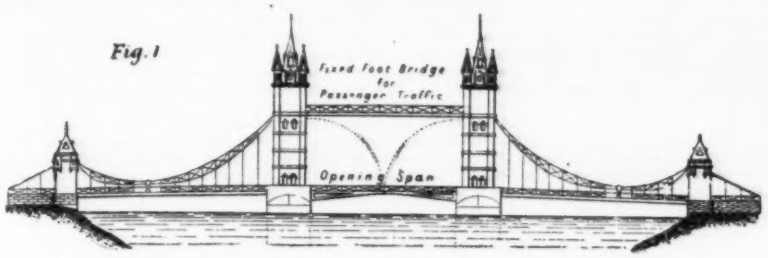
In plan it is a rectangle, 100 ft. in length of hull by 62 ft. in width, and draws 1 ft. 6 in. of water. At each end there are two prows; those on each side and at opposite ends are connected with each other by chains and wire ropes passing over pulley wheels on the bridge, so that they counterbalance. The inner ends of the prows are hinged to the structure of the bridge; and either of them can have its outer end lowered so that it may allow of connection with the shore, at the same time raising its fellow at the other end of the bridge. The fellow prows are connected by a deck at a level of about 3 ft. above the water; this deck forms the standing place for the wheeled traffic. The longitudinal center portion of the bridge is occupied by cabins, and engine and boiler room, with an upper or promenade deck approached by a flight of steps from either end.

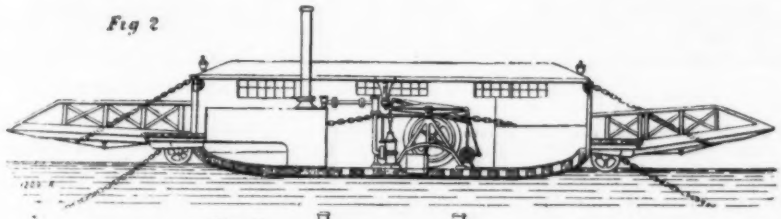
*Gearing and Engines.*—In the center of the length of the vessel there is a cross shaft, carrying a mortise wheel with wooden cogs, 12 ft. 4 in. in diameter to the pitch line; and on each end of this shaft there is a chain wheel 10 ft. 6 in. in diameter, over which the hauling chains pass. The chains travel through the vessel in water-tight iron troughs, which form part of the structure and are employed to assist in bracing it; the chains enter and leave through holes considerably above the water line, and are supported in the troughs upon pulleys or rollers. The mortise wheel is geared up with a shrouded pinion in the center of the length of the crankshaft of a pair of overhead compound surface condensing marine engines of ordinary type. The steam cylinders of these engines are 20 in. and 38 in. in diameter, with 30 in. stroke. The speed is 60 revolutions per minute. The engines draw their steam from two cylindrical boilers, each 6 ft. 6 in. in diameter of shell and 13 ft. long, and each having a single flue 3 ft. 3 in. internal diameter terminating in a combustion chamber, from which there are 92 tubes of 2¾ in. external diameter to the back end of the boiler; thence the products of combustion pass into the uptake and to the chimney and away.

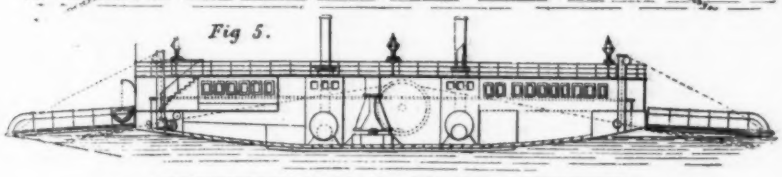
*Chains.*—The old chains will be used for the new bridge. They are anchored at the shore ends by being connected in vertical pits to heavy weights, which are assisted by strong springs, thus allowing of a certain amount of elasticity at the anchorage. The chains pass over pulleys at the top of the pits. The links are of mild steel 1⅛ in. in diameter, and are of the ordinary shape and without studs. The chains are of excessive strength for the work required of them; but this is one of those cases where the mere weight of metal is of advantage, for this weight allows of the chains being at a very steep angle with the horizontal when the bridge is crossing, thus permitting vessels drawing a great depth of water to approach nearer to the bridge. The angle at which the chains enter the bridge at the forward or hauling end is practically one of 45° to 50°, so that at some few feet from the front of the bridge there is from 20 ft. to 30 ft. depth of water over the chains. Further than this, the chains are the portion of the work which most readily wears out and which requires most frequent renewal. Their wear is largely due to their rubbing upon the gravel bottom of the harbor; and careful investigation has shown that it is desirable to make the chains as heavy as possible, with the object of preventing the necessity for their frequent replacement. The chain wheels on the bridge, by which the hauling is done, are made with fitted cast steel whelps or cogs, bolted into the hollow rim of the cast iron wheel, and shaped to suit the links of the chain. These are capable of ready renewal when worn.

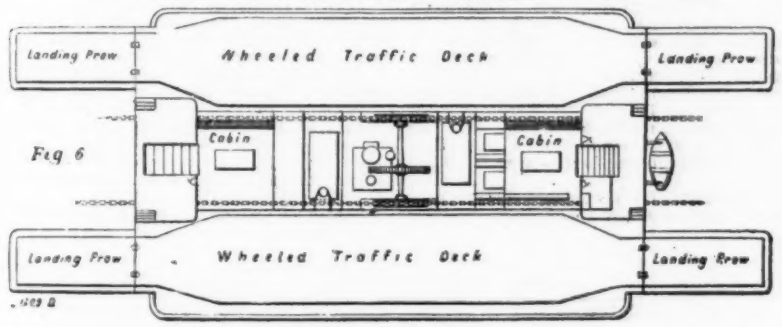
*Electric Lighting.*—There is nothing of especial note to comment upon in the engines or machinery of the bridge; and practically the main difference between the new bridge and that which it will displace is that the new one is of steel, and will be lit electrically, and that the engines and boilers are more modern in design and construction; while the old bridge was of iron and was lit by gas, which was filled into a gasholder carried in the bridge by a flexible pipe connected to the shore at the Portsmouth end at those times when ths bridge was waiting there for traffic. The electric light plant of the new bridge consists of two vertical high pressure engines, each coupled by a belt to a Paterson and Cooper dynamo. There are in all on the bridge lights equal to thirty-nine lamps of 16-candle power; and in addition to these sufficient power has been allowed in the engines for two arc deck lights of 1,200 candle power each. One of the engines and dynamos will do the whole of the work, the other being kept as a stand-by. Advantage has been taken of the fact of having these engines to make arrangements by which, in case of accident to the main engines, or if for any reason these cannot be worked, the bridge could be slowly brought to land by means of gearing working the main cross shaft through its mortise wheel. This gearing can also be worked by hand if desired.

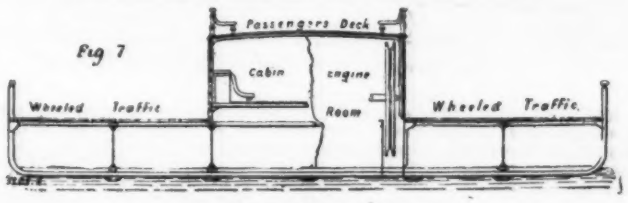
The hull of the bridge is divided by transverse watertight bulkheads into five compartments; and there are two continuous longitudinal girders, one on each side of the bridge, formed by the sides of the cabins carried down to the skin of the vessel to strengthen it longitudinally. A journey is made by the present bridge, and will be made by the new one, in about five or six minutes, the distance being about 600 yards or three-eighths of a mile. The advertised time for the starting of the bridge from the Portsmouth side is at the half hour and at the hour, and from the Gosport side at the quarter to and at the quarter past the hour. Under



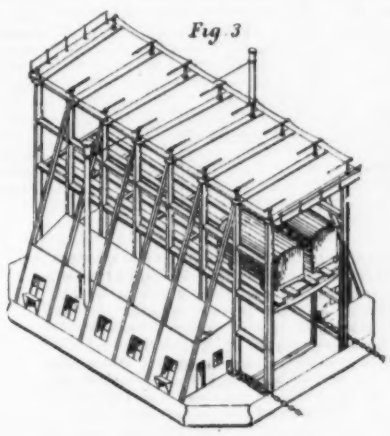



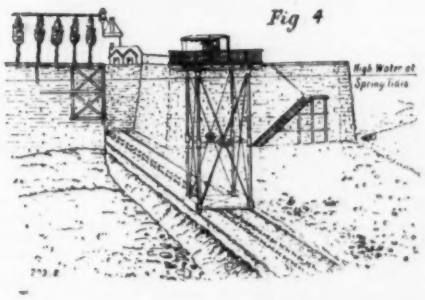




FLOATING BRIDGE



these circumstances it will be seen that it may be necessary, should a wheeled vehicle desiring to cross arrive just as the bridge has started to the other side, for it to wait for nearly half an hour before it can proceed on its journey. This is a disadvantage which has to be borne by the wheeled traffic; but in the case of the ordinary foot traffic the bridge company have provided, in addition to the bridge itself, a service of steam launches crossing in the intervals between the times of the bridge starting, so that as a fact it is possible for a passenger to cross without having to wait for more than some seven to ten minutes at the utmost. It is only within the last few years that these launches have been established. Previously it was necessary to wait for the bridge or to take a Portsmouth wherry, there being a regular waterman's ferry plying for fares between these points. The bridge will take across as a maximum 1,200 foot passengers, or say one full regiment of soldiers.

## TOGGLE JOINT FOR MULTIPLYING MOTION.

IN arranging a treadle to be operated by foot power, it can easily be connected up in such a manner that the foot will rise in almost any portion of a revolution

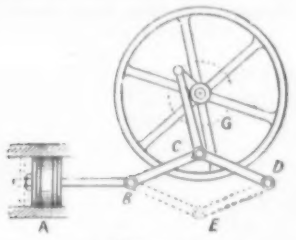



FIG. 1.

and take the remainder of the turn to make the descent again. Some prefer having a treadle rise quickly, and take nearly three-quarters of a turn to allow it to fall again, thinking that all the power applied by the foot will be made the most use of, while others prefer just the reverse, on the grounds that the leverage is the greatest by this method, when in reality there can be no difference in the power deriving by either arrangement. There may be a convenience that will work in handy, depending on the class of work that is to be done, and this has much to do with the way a new device may take on the market. We have been taking an interest in a device for giving two treadle

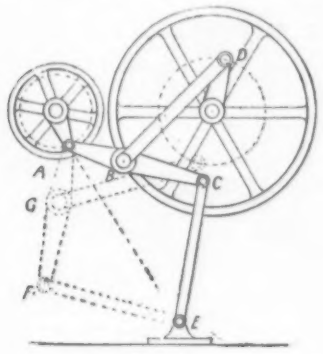



FIG. 2.

movements for one turn of the flywheel where the toggle joint is made use of, and have already applied it to a high speed engine, in the hope of reducing the speed of the driving wheel, or rather allowing the reciprocating parts to double their ratio of speed without disturbing the rotative parts of the engine. The piston is made to operate the crank of a flywheel by means of a piston and two connecting rods jointed together, as shown in Fig. 1. The piston, A, moves back and forth for a short distance, drawing the two connecting rods, B, C, and C, D, first out into a straight line, then pitching them up into the form of a pair of rafters, first up and then down, as shown by the dotted lines, giving

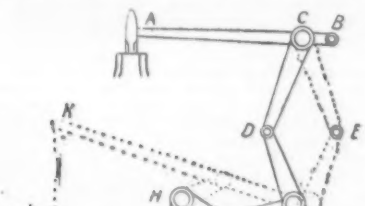


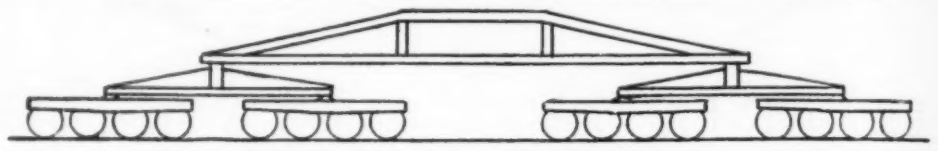

FIG. 3.

two strokes to the piston for one stroke from C to E. With this knuckle joint all that is required now is to connect this joint with the crank arm, F, G, by means of a connecting rod, C, F, and the engine is ready for its valve motion.

An attempt has been made to connect two crank arms in this manner, with the view of driving one with twice the number of turns as the other. The crank, A, in Fig. 2, operates the two rods knuckle-joint fashion, one end being made fast by a hinge on the floor, at E. The driven crank arm, D, is connected with the knuckle joint, at B, which has a stroke equal to the diameter of the crank pin circle of the driven crank arm for over two turns of the driving crank. It has been found that the motion of the driven wheel is very irregular, with as many as four dead centers for every turn of the wheel, but it is hoped that, by having an elastic connecting rod, and weighty flywheels, a smooth running movement will be obtained. This dead center movement was first attempted as a foot power for driving a beading hammer, as shown in Fig. 3. The hammer, A, B, was jointed to a knuckle joint near the fulcrum, at C. To operate this knuckle joint another joint of the same class was arranged at right angles, H, C, F, with one side extended far enough for the foot, I, to rest upon. It is plain to be seen that when the foot is raised to the position shown at K, and brought down again, that the hammer must strike four rapid blows. Raising the foot one-half this distance diminishes the number accordingly, and to bring the hammer to correspond with the treadle only requires the foot to rise and fall but one-fourth its full travel. The joint also serves to guide the point where the foot is applied in a straight line. Such a device as this, where nothing but link work is used, should be available for other purposes, such as for driving jig saws and mortising machines, where foot power is relied upon as a motive power.—*Boston Journal of Commerce.*

## HEAVY FREIGHT CARS.

THE Pennsylvania Railroad Company are now engaged upon the construction of the strongest car ever made in this or any other country. It is designed for the conveyance of the 124 ton Krupp gun, which, notwithstanding the report to the contrary, originating we believe with the *Army and Navy Journal*, and generally circulated by the press, will form an interesting feature of the exhibit of that company at the World's Columbian Exposition. As will be seen by the accompanying sketch, the car will be mounted upon four 8 wheel trucks, each pair of which will be connected with each other by an iron framework, the ends of which will be pivoted to the center of the truck. These frames will be in turn surmounted by another and

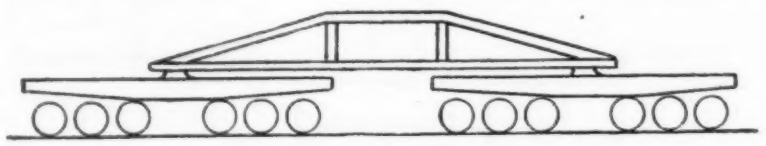


CAR FOR 124 TON KRUPP GUN.

larger frame, which will be pivoted on the centers of each of the other two and upon which it will rest. This upper framework, which, like the other two, is wholly of iron, may be compared to a huge trough, in which the gun will rest during its journey.

The second car is designed for the transportation of a 65 ton gun, which will also be a part of the same exhibit. It is of somewhat similar construction, as may be seen by the sketch, which is also shown herewith. These two guns will be landed at Sparrow's Point, near Baltimore, that being the only place on the Atlantic coast where a derrick of sufficient size to handle these guns is located. From this point they will be transported to Chicago by the Pennsylvania and Pittsburg, Ft. Wayne and Chicago Railroads. These guns are expected to arrive in this country early in the ensuing year, together with several other pieces of heavy ordnance, and an immense armor plate manufactured by the Krupp Co. The negotiations which have been pending between the Pennsylvania Railroad Co. and the American representatives of the Krupp Co. for several months, for the construction of suitable cars and the transportation of the cannon, were lately consummated and a formal contract for the work has been executed.

According to the terms of the contract the Pennsylvania Railroad Co. agrees to build and have ready to



CAR FOR 65 TON KRUPP GUN.

deliver by January 1, 1893, the two cars referred to. It is possible that arrangements will be made whereby these cars may form a part of the exhibit of the Pennsylvania Railroad at the exposition.—*Railway Review.*

## THE DOLCOATH TIN MINE, CORNWALL.

WM. P. BLAKE.

THE short notice of the celebrated Dolcoath tin mine of Cornwall which appeared in the *Engineering and Mining Journal* of September 24 was very welcome to me, as it must also have been to many of your readers, for Dolcoath may be regarded as a typical mine, and the leading tin mine of the world. But the notice seemed too brief for such a grand old mine as the Dolcoath truly is—a mine with a history of a century or more; with three shafts, each more than half a mile in depth; with levels at regular distances, following a lode which yields copper ore near the surface and tin ore below. There is not a mine which is worked with more system and regularity, nor one more interesting to the mining geologist and the practical miner. Having had the privilege of visiting it, and of being entertained by its manager, Captain Josiah Thomas, one of the ablest of the many able Cornish mine captains, I may be excused for asking you to give space to this somewhat more extended notice.

On the occasion of the visit of the Royal Institution of Cornwall to the mine at the end of last August, the members and their friends were entertained at luncheon by Captain Thomas, who presented them with a printed card giving the salient facts concerning the property.

The mine was worked in the last century to a depth of 160 fathoms, and is believed to have produced about £1,250,000 worth of copper ore. The present company commenced working in 1799. The total amount of calls made is £45,252, and from this investment the mine has received as follows:

| | |
|---|---|
| Copper ores sold | £2,328,435 |
| Tin ores sold | 3,249,386 |
| Arsenic, silver, cobalt, etc., sold | 23,156 |
| Total dividends | £5,600,975 |
| Dividends paid on copper to 1836 | 157,541 |
| Dividends paid on tin from 1853 to the last meeting | 699,788 |
| Total dividends | £857,329 |

At the quarterly meeting last June the accounts showed:

| | | Per ton of tin. |
|---|---|---|
| Labor cost | $62,905* | $105.50 |
| Tribute | 6,525 | 10.95 |
| Supplies | 32,160 | 54.10 |
| Stannary dues | 9,385 | 15.75 |
| Hospital, etc. | 2,110 | 3.55 |
| | $113,085 | $189.85 |

Net receipts from the sale of 594·5 tons of black tin at $281.40 per ton were $157,280; the net profits for the 12 weeks were therefore $44,195. For the 12 weeks ended September 3 the profits amounted in round figures to $55,000. A dividend of £9,400 was declared for each quarter.

The engine shaft had then reached a depth of 13 fathoms below the 412 fathom level, but since then it has been carried to a depth of 455 fathoms, or 2,742 ft. The number of hands employed is about 1,300. Many young women, "bal maidens," are employed in light work upon the dressing floors. It is a very interesting sight to see 100 or more young women, neatly dressed, and with large snowy white aprons and caps, working together at the buddles, concentrating black tin and singing Wesleyan hymns in unison as they work.

Between the years 1836 and 1853 no dividends were paid, the mine having become poor in copper ore, and not very rich in tin. Dolcoath is no exception to the general rule in Cornwall that where the lodes pass from the killas (slate) into the granite, the copper ore found in the slate gives out and tin ore comes in. I found this to be the case in every instance. In the slaty rocks the lodes bear copper ore, and in the granite tin ore. One of the Cornish mines has been cited as an example of this by some writers, but it is the rule for all.

The deepest run upon the Dolcoath lode is 440 fathoms from grass, and the lode at that depth is richer in tin ore than it was found to be at any level above it, showing no lack of mineralization at this great depth. In the new east shaft, which in June was down 8 fathoms below the 312 fathom level, the lode has a fine appearance for the whole of the distance, varying in value from £80 to £100 per fathom. A massive and rich run of ore was expected for at least 80 fathoms east of this shaft. It is claimed to be a striking characteristic of Dolcoath that as the mine has deepened so the mineral wealth has increased, and as the deepest point yet reached is the richest, this claim is not without foundation. It is a fact which has great significance and value to all mines, and is separately commented upon in another article.

In the central and northern portion of the mine there is a piece of poor ground for about 80 fathoms in length, where Capt. Thomas, instead of driving levels as usual 19 fathoms apart, has only driven two levels below the 254 fathom level, one at the 314 fathom and the other at the 375 fathom level, thus saving considerable expense. He has recently introduced power drills for opening and breaking ground.

At the June meeting the manager directed the attention of the shareholders to the importance of adding to the stamping capacity of the dressing works, in order to be able to stamp the tin stuff as fast as raised from the mine. He highly commended to them the American or Californian pattern of stamps mills as far superior to the old fashioned Cornish stamp, an opinion which he has made more emphatic since his recent brief visit to the tin mines of Dakota. At a banquet on his return he said that he saw one stamp mill in the United States stamping more stuff daily than all the mills together in Cornwall.

The plans for the new 40 stamp mill were shown in June and the contract was given to the Hayle Foundry at £2,775, but the total cost, perhaps including the engine, is estimated at £5,000. The firm of Messrs. Harvey & Co. has been making stamp mills upon the Californian pattern for the gold fields of Africa. It is expected at Dolcoath that with the mine improving in depth for tin ore, and the increased stamping capacity above, the production of black tin will be largely increased. The new mill is erecting on the eastern side of the valley going toward Cook's Kitchen.

The Dolcoath set, nearly 1,100 fathoms long, adjoins Cook's Kitchen, and there is a space of only about 25 fathoms unworked between them, but the Cook's Kitchen lode is said to be heaved 70 fathoms to one side, so that connection of the two mines is not expected.

Captain Thomas was intrusted with the manage-

* Estimating the pound sterling at $5.

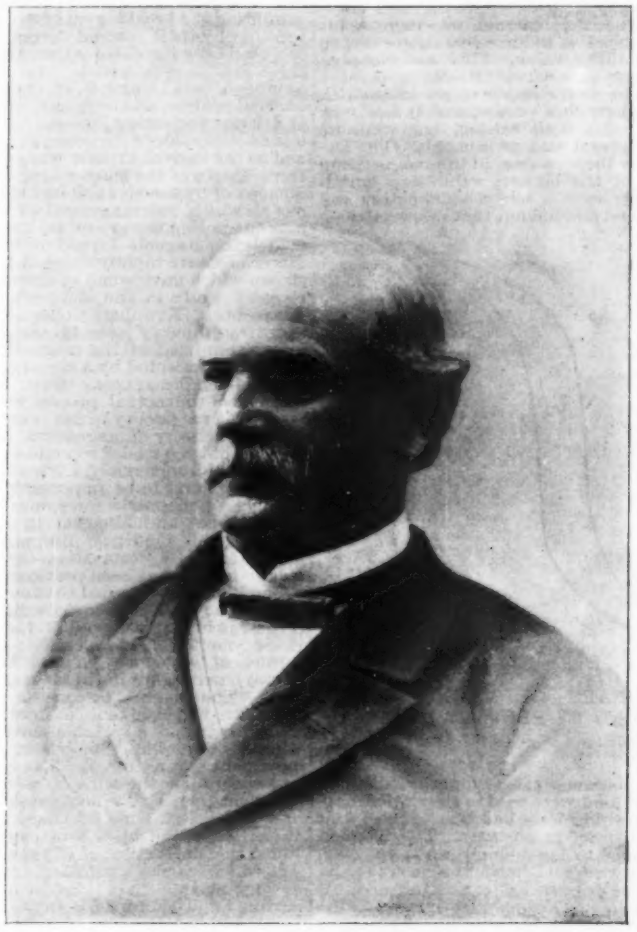
ment of Dolcoath when he was 30 years of age and has been the manager for 24 years. He has made all the underground surveys, and the beautiful section of the mine hanging in the counting room shows what a great and intricate task this must have been. The surveys and the plotting are kept well up with the work.

The mine has not only been a most profitable venture to the owners, but it has been a blessing to many households and to the region about it. It has been really a great practical school of mining, and many successful Cornishmen in the United States and other lands can look back with pride and gratitude to the days they spent in the levels and stopes of Dolcoath.—*Engineering and Mining Journal.*

## THE LATE PROFESSOR WILLIAM P. TROWBRIDGE.

FOR the second time this year has Columbia College had occasion to mourn a death among her professors, first in the death of Wm. Guy Peck, Professor of Mechanics; now in that of Gen. William Petit Trowbridge, professor and head of the department of engineering in the School of Mines, who died very suddenly of heart failure at his home in New Haven, Conn., on August 12.

Prof. Trowbridge was born at Troy, Oakland County, Mich., on May 25, 1828. At the age of sixteen, after receiving such an education as was afforded by the county schools, he received an appointment as cadet at West Point. He was graduated at the head of his class in 1848, having, moreover, acted as assistant professor of chemistry during the last year of his course,



THE LATE PROFESSOR TROWBRIDGE.

and was assigned to the engineer corps, with the rank of brevet second lieutenant. Being desirous of joining the United States coast survey, he spent the two years following his graduation in astronomical work at the observatory of West Point. During the year 1850-51 he served with a company of sappers, miners and pontooners, and in the year following secured a coveted position on the coast survey, then conducted by the late Alexander D. Bache. He was assigned to duty on the primary triangulation of the coast of Maine, where the entire work was placed under his charge. His work on the survey lasted until 1856, during which time he made surveys of the Appomattox and James Rivers, in Virginia, of the Dutch Gap, where he recommended the cut-off canal, afterward constructed, and, finally, on the Pacific coast. This latter survey, which included astronomical, tidal and magnetic observations, was conducted by him. Full accounts of his work on the survey can be found in the Proceedings of the American Association for the Advancement of Science, to which he was a frequent contributor. In 1854 he was promoted to a first lieutenancy, the second being given him in 1849. In 1856 he resigned from the army to accept the chair of mathematics in the University of Michigan, but his early inclination for coast survey work was not to be so easily overcome, and he resigned his professorship in the following year to accept, at the request of Mr. Bache, the post of scientific secretary to the superintendent of the survey.

While holding this position, Prof. Trowbridge prepared for publication the results of the Gulf Stream exploration. In 1860 he superintended the erection of the automatic registering magnetic observatory at Key West, Fla. In the following year he prepared the chart of the Southern coast, for the use of the United States Navy, and subsequently made a hektographic survey from Narragansett Bay, in Rhode Island, at which place the establishment of the navy yard had been proposed by the government.

At the outbreak of the war, Prof. Trowbridge re-entered the Union army, and served throughout the war. He was placed in charge of the engineering agency, in New York City, which supplied materials for fortification. From 1862 to 1865, he also occupied the position of superintending engineer of the fort at Willets Point. He also took charge of the harbors of Fort Schuyler and Governor's Island, and New York Harbor.

He again resigned his position in the army, and for the four years following 1865 he was vice-president of the Novelty Iron Works, in New York City.

In 1870, he was called to take charge of dynamical engineering in the Sheffield Scientific School, Yale College, which position he held for the ensuing seven years.

From 1872 to 1876, he was adjutant-general of the State of Connecticut; also commissioner of the State for the building of the new capitol at Hartford. During this time he was commissioner for the establishment of the harbor lines of the city of New Haven and for building a bridge across the Quinnipiac River. In 1877 he was elected professor of engineering at the School of Mines, Columbia College, and was made head of the department. This post he held at the time of his death.

From 1889 to 1891 he was chief special agent of the tenth United States census for collecting statistics relating to power and machinery employed in manufactures.

Prof. Trowbridge was a member of many scientific societies, among them being the New York Academy of Science, the American Association for the Advancement of Science, and the National Academy of Science, to which latter he was elected in 1882. He has held the position of vice-president of the New York Academy of Science, and the same in the American Association, in which latter capacity he presided over the section of mechanical science in 1881.

The degree of A.M. was conferred upon Prof. Trowbridge by the Rochester University, in 1856, and by Yale, in 1870. The degree of Ph.D., by Princeton University, in 1880. In 1883, Trinity College conferred upon him the honorary degree of LL.D., this being followed by that of the University of Michigan, in 1887.

Prof. Trowbridge took to the school talents of a high order combined with unflagging zeal. His work at the School of Mines was of such a high order as to make it no easy matter to fill his place. Although not what might be called a brilliant teacher, his grasp of the complex subjects which he taught was so complete that, with his scientific bent of mind, he never failed to make his students understand the subject upon which he happened to be lecturing.

That this was true, however, was not alone due to his clearness and conciseness of description; a part should be credited to the unfailing kindliness and patience of his nature. In the School of Mines, a certain amount of ground must be daily covered, and the work is not easy, more especially if a mathematical bent of mind is lacking.

To those who occasionally did not understand the subject in hand, Prof. Trowbridge was always ready to lend his time, when they came seeking his aid, while to those who could not keep up he gave the advice to pursue some other course for which their talents seemed to fit them, and this was done in such a manner that no sting of disappointment was left behind. He was the friend as well as instructor, and naturally his students loved him.

Six children survive him, three sons and three daughters. His eldest son was associated with him in instruction at Columbia College.—*The Engineering and Mining Journal.*

## THE PHOTO-ELECTRIC CELLS.*

G. M. MINCHIN.

THE cells which are employed for obtaining electromotive force from the light of the stars and planets are known as *seleno-aluminum* cells. They are constructed in the following way. Take a small flat strip of aluminum about a quarter of an inch long and one-sixteenth of an inch broad; let this be heated on a clean iron plate placed over a Bunsen flame, and while it is hot let a very small bubble of melted selenium be rapidly and uniformly spread by means of a hot glass rod over about one-third of the length of the aluminum strip, the selenium forming a very thin layer.

When this layer is spread, the little plate must be rapidly removed from the hot iron plate and thus cooled, while the Bunsen flame is, at the same time, removed from under the iron plate. The latter plate having become cooler, replace the aluminum strip on it, and then gradually heat up the iron plate from beneath by means of the Bunsen flame. As a result of this gradual heating, the aspect of the selenium layer on the aluminum changes; this layer changes from black to gray in appearance, and in the latter state it is sensitive to light. But to give the layer its maximum sensitiveness, several remeltings may be necessary, until a gray surface of a somewhat brownish tinge, quite devoid of glossy streaks, is produced. Nothing but an actual sight of the process of making a sensitive plate can give the reader a correct notion of the proper kind of surface. Assuming this surface produced by the gradual process of heating above referred to, the Bunsen flame is removed, and the seleno-aluminum plate is allowed to cool on the iron plate. When it has cooled (after about ten minutes) it is taken and joined to a very fine platinum wire which is inserted through a fine hole previously bored through the uncoated portion of the aluminum plate; this platinum wire is tightly pinched to the plate, so as to make a good electrical contact.

So far for the sensitive plate. The cell into which it is to be inserted is a very fine glass tube about 1½ in. long, into which a platinum wire pinched to a clean plate of aluminum has been sealed; the size of this latter plate is immaterial—it may be a mere speck of the metal at the end of the platinum wire; it is the inactive plate of the cell. Into this glass tube, thus closed at one end, is inserted (by means of a pipette with a capillary stem) a quantity of pure acetone sufficient to occupy about one-quarter of the length of the tube; and then the sensitive plate is inserted until its sensitive extremity is very nearly in contact with the inactive plate, the whole of the sensitized part of the plate being covered by the acetone.

The platinum wire of the sensitive plate which now projects through the open end of the cell must be sealed into the tube, the end of the tube being, of course, completely closed by the sealing. Much practice is here necessary to prevent the vapor of the acetone from bursting the heated end of the tube; but the process becomes easy enough with practice.

The cell is now made, and if its poles are connected with those of an electrometer, and light is allowed to fall on the sensitive plate, an electromotive force will be indicated.

Shortly after the cell has been made, it is wonderfully quick in its response to changes of the incident light—almost instantaneous, in fact; but after about twenty-four hours, it becomes slower in its response. The cause of this is not yet quite known; but it has been found that a constant *regime* can be produced and kept up for months by—

(*a*) Using perfectly pure acetone.

(*b*) Using perfectly pure selenium.

(*c*) Turning the cell upside down when it is not required for use, and thoroughly shaking the liquid away from the plates.

The complete and permanent elimination of sluggishness from the cell is under consideration at present.

As regards the *magnitude* of the electromotive forces produced, it may be said that ordinary diffused daylight falling on the sensitive plate will give an E. M. F. of about ¼ volt, which is surprisingly great. A candle at a distance of seven feet will give about $\frac{1}{10}$ volt.

Light of all refrangibilities from red to violet is effective—and this fact distinguishes this cell from every other known photo-electric cell—the maximum effect being produced by the yellow rays; but there is not very much difference between the effects of the various parts of the spectrum.

By putting a number of these cells in series, the effect is multiplied by the number employed; thus ten cells in series will give ten times the E. M. F. of one cell.

Hence for stellar observations the cells should be made as small as possible, and cells much smaller than the typical one above described have been made.

Does anything depend on the *size* of the sensitive plate? It would appear that nothing depends on the size, and that therefore a mere pin point of sensitive surface is as effective as a square centimeter. Perhaps this is so; but it has been found that the maximum E. M. F. is never given when the sensitive surface is as small as a large pin head. For stellar observations this is most unfortunate; but it is highly probable that the result is due to the large size and capacity of the electrometers at present at our disposal. There is good reason to think that, with an extremely small electrometer, the pin-head plates will give as good results as the larger ones. Certainly with a common quadrant electrometer a sensitive surface six millimeters long and two millimeters wide gives as good a result as a surface ten times as large. For the light of the moon there is no difficulty in making batteries of photo-cells containing ten or twenty cells.

* Communicated by the author.

With Mr. Monck's refracting telescope, the image of Mars would take, perhaps, *three* cells, and an unmistakable E. M. F. should be produced. Jupiter would take more; but it would be difficult to cover *completely* the sensitive surfaces of *two* cells with the light of Vega. (The *whole* of the sensitive surface of every kind of photo-cell must be covered by the incident light to obtain the full effect.)

The best existing form of electrometer is Clifton's form of Thomson's quadrant. Some very slight improvements in this instrument would render it fairly fit for photo-electric observations in an observatory. When working well (well insulated and preserved from draughts of air) it will give about 200 half millimeters deflection on a scale distant one meter from the mirror for one volt. Hence a candle at seven feet from one photo-cell has been found to give about seven divisions deflection. Thus it is very easy to get results from moonlight: and with a clear sky and the absence of air currents, the light of a planet should be easily measurable.

For a given source of light, the E. M. F. developed in a photo-cell varies inversely as the distance of the light from the cell.

Instead of an electrometer, a high resistance reflecting galvanometer could be used with photo-cells; but the former instrument is far preferable, because it is not advisable to allow currents to circulate in the cell. A galvanometer and a condenser (the latter charged by the cell while light falls on it, and then suddenly discharged through the galvanometer) give enormous deflections with moonlight; but this method is objectionable.

So far as is known at present, these cells will stand any amount of exposure to light without deterioration, provided that they are always employed with an electrometer, *i. e.*, open-circuited.

Mr. Monck and Professor Dixon have, I believe, succeeded in obtaining results from the light of Mars under most unfavorable atmospheric conditions. I remained in Dublin for a week in the beginning of August to try the cells with the stars; but during this time not a single opportunity occurred, the sky being heavily clouded every night.

When a photo-battery has been used with a strong light, such as that of the moon, the deflection on the electrometer scale takes some time to disappear when the light has been shut off. This deflection can, however, be very quickly got rid of without injury to the battery by an instantaneous connection of the battery with a Daniell cell whose zinc pole is for the moment connected with the sensitive pole of the battery, the copper being connected with the insensitive pole and with earth.—*Astronomy and Astro-Physics.*

## MAGNETIC INDUCTION.*

By Prof. J. A. EWING.

THE lecturer remarked that it was no less than forty-five years since the magnetic properties of materials had formed the subject of an evening discourse before the British Association. At the Oxford meeting in 1847 the lecturer was Michael Faraday, who had only a little while before made his great discovery of diamagnetism and been led to the splendid generalization that all substances are in one way or other, and in greater or less degree, susceptible of magnetic influence. And it was an interesting coincidence that in the same year, partly indeed at that same Oxford meeting of the association, the foundation of the modern mathematical treatment of magnetism had been laid by that infant phenomenon whom in the vigor of his maturity we were now learning to call Lord Kelvin. Discarding the arbitrary hypotheses of earlier theoretical writers, Lord Kelvin, then a stripling at Cambridge, had proceeded to give mathematical expression to the observations and intuitions of Faraday. In recent years the science of magnetism had advanced fast, keeping pace with the advance of its industrial applications. In common with other branches of electricity it had discovered the advantage of being useful.

The debt which practice owed to science had been repaid with interest. In other departments of science it might be true that there were devotees whose chief pride in their work lay in their reflection that it could never be of any use to anybody: this temper of mind was not possible to an electrician. The language of electricians had passed with bewildering rapidity into acts of Parliament and provisional orders of the Board of Trade, and the demands of industry had stimulated discovery and fostered exactness in measurement. It was the beneficent reaction of practice on science that had enabled the great work of the electrical standards committee of the British Association to be brought to a successful issue. As a fruit of that work electricians were in high hope that this Edinburgh meeting would result in an international agreement with regard to the electrical units, so that whatever the great powers might find to differ about, they would at least be of one mind as to the magnitude of the volt, the ampere, and the ohm. In the co-operation of Prof. von Helmholtz on the part of Germany and of M. Mascart on the part of France, with Lords Kelvin and Rayleigh and their English colleagues, there were surely the elements of a triple alliance which should secure to the electrical world peace, not only with honor, but with precision.

The lecture of Faraday in 1847 had dealt with the condition induced by magnetic force in matter not ordinarily magnetic. Substances were broadly divisible into two classes, those which were strongly susceptible to magnetic influence and those that were only very feebly susceptible. The latter was by far the most numerous class, and it was with it that Faraday dealt in his lecture. The strongly magnetic substances were iron and its various derivatives, which passed by the general name of steel, also nickel and cobalt. A recent discovery by Prof. Dewar seemed to require that oxygen, in the liquid state, should be added to this list. The lecturer proposed to confine his attention to the phenomena of magnetization which were exhibited by the strongly magnetic metals. Let any one of these metals be submitted to the action of a magnetizing force such as would be produced if an electric current were passed through a coil of insulated wire surrounding the metal. As the current was gradually increased, the magnetization passed through three stages. It began very gradually; at first, while the current was still weak, there was but little magnetism developed. Then a stage came on in which the magnetic state was acquired with great rapidity; a small increase in the current now caused an enormous gain of magnetism. Finally, the process passed into a third stage, when

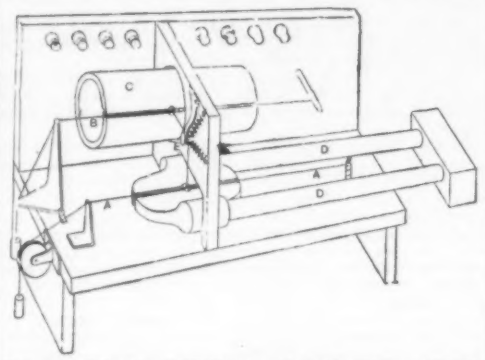



FIG. 1.—PROF. EWING'S MAGNETIC CURVE TRACER—GENERAL VIEW OF APPARATUS.

the magnetism was again acquired slowly, and however much the magnetizing current was increased it was found to be impossible to force the magnetism to exceed a certain limiting value. This was the phenomenon of magnetic saturation. Recent researches had given definiteness to the rather vague idea which used to be expressed by this phrase, and it was now known not only that a limit existed, but what its values were in the several magnetic metals. The lecturer illustrated the three stages in the magnetizing process by means of the lantern, exhibiting curves which showed the connection between magnetism and magnetizing force, and pointed out that in special cases

FIG. 2.—PHOTOGRAPH OF MAGNETIZATION CURVE TRACED BY PROF. EWING'S MAGNETIC TRACER.

the three stages became extraordinarily distinct. Curves of the same kind were used to show what happened after a magnetizing force had been applied, if it were withdrawn or varied in any way. The magnetism in all cases tended to lag behind when the magnetizing force was varied, and hence the curves in any cyclic process became loops inclosing a certain area. It had been proved that this area served to measure the energy expended in carrying the substance through a cyclic magnetizing process, the reason why energy had to be spent being the tendency which the magnetism always had to lag behind the force that was operating to change it. To this tendency he had given the name

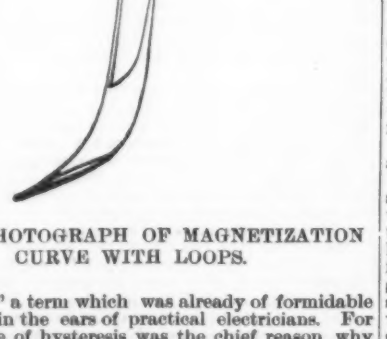


FIG. 3.—PHOTOGRAPH OF MAGNETIZATION CURVE WITH LOOPS.

"hysteresis," a term which was already of formidable significance in the ears of practical electricians. For the existence of hysteresis was the chief reason why the transformers which were used in alternate current systems of electrical distribution absorbed wastefully a considerable amount of power. The iron core of a transformer was being carried through a cycle of magnetization from a positive to a negative value and back again some 80 or 100 or 120 times a second, and every one of these periodic reversals of magnetism implied a waste of energy, which went on even when no useful current was being drawn off. It was a question of considerable practical interest, whether the amount of work wasted on the iron of a transformer was the same per cycle at high speeds of reversal such as were usual in practice as it was in the low speed laboratory experiments, by the help of which these cyclic curves had been drawn.

The lecturer proceeded to give some account of molecular theories which had been framed to account for the characteristics of the magnetizing process. It was suggested, originally by Weber, that the molecules of iron are always little magnets, and that when the iron, as a whole, is not magnetized, it is because as many of the molecular magnets are facing one way as another. According to this view, the process of magnetization consists in turning the molecular magnets round, so that they face, more or less, one way. When a very strong magnetizing force is applied, the molecules are forced all to face one way; the piece is then saturated. To explain why they did not at once turn round completely when any magnetizing force was applied, Weber postulated an arbitrary directing force, which tended to hold them in their original direction. The lecturer proceeded to show by means of experiments conducted on the projecting table of the lantern, and shown on a large scale on the screen, that no arbitrary directing force was necessary. The mutual actions of the molecular magnets on one another supplied all the control that was required. It accounted completely for the three stages of the magnetizing process and for all the phenomena of hysteresis. It accounted also for the effects which were found to be produced by mechanical vibration and mechanical strain. Experiments were made exhibiting the breaking up of molecular groups, bound together by their mutual forces, under the influence of a gradually increased external directing force. In these experiments models were used, consisting of a number of small magnets, pivoted like compass needles on fixed centers, and arranged on the horizontal table of a large projecting lantern. A pair of coils placed one on either side of the group supplied deflecting force, and as the current in these was gradually increased the three stages of the magnetizing process and the phenomena of hysteresis exhibited themselves in the manner in which rearrangement of the elementary magnets composing the group took place. In some of the models the magnets turned under water, so that their vibrations were rapidly damped out. Slides were also shown which gave some of the results of observations recently made in the lecturer's laboratory by Miss Klaassen, of Newnham College, which demonstrated an extraordinarily close agreement between the phenomena noticed in the magnetization of actual iron and those presented by a model consisting of groups of little pivoted magnets. Even the less conspicuous features of the actual process were reproduced in the model with a fidelity which went far to confirm this molecular theory of magnetism. It was shown, for instance, that the model reproduces a phenomenon familiar in real iron, namely, the tendency which magnetic changes exhibit to be imperfectly cyclic, under cyclic changes of magnetic force, until these are repeated several times, and also that in the model, just as in real iron, this tendency disappears if a process of demagnetizing by reversals of gradually diminishing magnetic force has been previously gone through.

The lecturer proceeded to show in action a novel apparatus he had devised to exhibit the magnetizing process in actual iron, and to test the magnetic qualities of metals. This magnetic curve tracer (Fig. 1) consists of two wires—AA and BB—tightly stretched in two narrow gaps in the magnets, DD and C respectively. The magnet, C, consists of a piece of slotted iron tube, which is kept constantly magnetized. Consequently, when a variable current passes along the wire, BB, that wire sags out or in, giving azimuthal movement to a mirror, E. The variable current which passes through the wire, B, serves to magnetize the electromagnet, DD, which consists of two bars of the iron to be tested, sunk into fixed pole pieces and united at the back end by a short yoke piece of soft iron. When the magnetism of DD varies it causes the wire, AA, which carries a constant current, to sag up and down, and this gives movement in altitude to the mirror, E. The mirror is pivoted on a single needle point, and has freedom to respond to the motion of both the stretched wires, AA and BB. Since its azimuth movement is proportional to the magnetizing current, and its altitude movement is proportional to the magnetism acquired by DD, the mirror causes a spot of light reflected from it to trace out the ordinary magnetization curve, showing the relation of magnetism to magnetizing force. By making the variable current change continuously from a positive to an equal negative value and back again, a complete cycle of magnetization was performed in the bars, DD, and in this way the magnetic characteristics of the bars could be completely determined in a few seconds. The lecturer proceeded to test in succession a pair of wrought iron bars, then a pair of hard steel bars, and finally a pair of cast iron bars, causing the cyclic curve for each material to be automatically drawn on the screen, on a very large scale, to exhibit the features of difference. The mirror and other moving parts of the apparatus were so dead beat that it was possible to go through a cycle ten or even twenty times a second without experiencing inconvenience from the effects of inertia.

In that case, however, the iron must be laminated to avoid sluggishness in the magnetizing process itself. Using an instrument with a magnet consisting of a split ring of iron wire, a process of periodic reversal was performed at a speed sufficient to make the curve traced out by the light spot become a continuously luminous line (Fig. 2), and the process of demagnetising by reversals was illustrated by making this curve gradually contract itself to zero by slowly reducing the strength of the current while the rapid periodic reversals were continued. The effect was also shown of superposing one periodic alternation upon another, by which loops resembling those of Fig. 3 were drawn. The lecturer pointed out that these experiments went some way toward answering the question whether the magnetizing process went on in the same way, and involved the same dissipation of energy through hysteresis, at high speeds as at low speeds. He concluded by

* Abstract of an evening lecture delivered before the British Association at Edinburgh, August 8, 1892, by J. A. Ewing, M.A., F.R.S., Professor of Mechanism and Applied Mechanics, Cambridge University.—*Nature.*

expressing the hope that this apparatus would prove of some service to the builders of dynamos and transformers by giving them a novel means of testing the magnetic properties of their iron with great completeness and in a manner sufficiently simple for workshop use.

## RESTORATION OF MASTODON AMERICANUS, CUVIER.

By O. C. MARSH.

THE great abundance and good preservation of the remains of the American *mastodon* have led to various restorations of the skeleton. The best known of these is that made by Prof. Richard Owen, in 1846, based upon a skeleton from Missouri now in the British Museum.* Another restoration was made a few years later by Dr. J. C. Warren, based mainly on a very perfect skeleton from Orange County, New York.† This skeleton is now preserved in the Warren Museum in Boston. A third restoration was made by Prof. James Hall, from a skeleton found at Cohoes, New York, and now in the State Museum of Natural History, in Albany.‡ These restorations are all of importance, and taken together have made clear to anatomists nearly all the essential features of the skeleton of this well-known species.

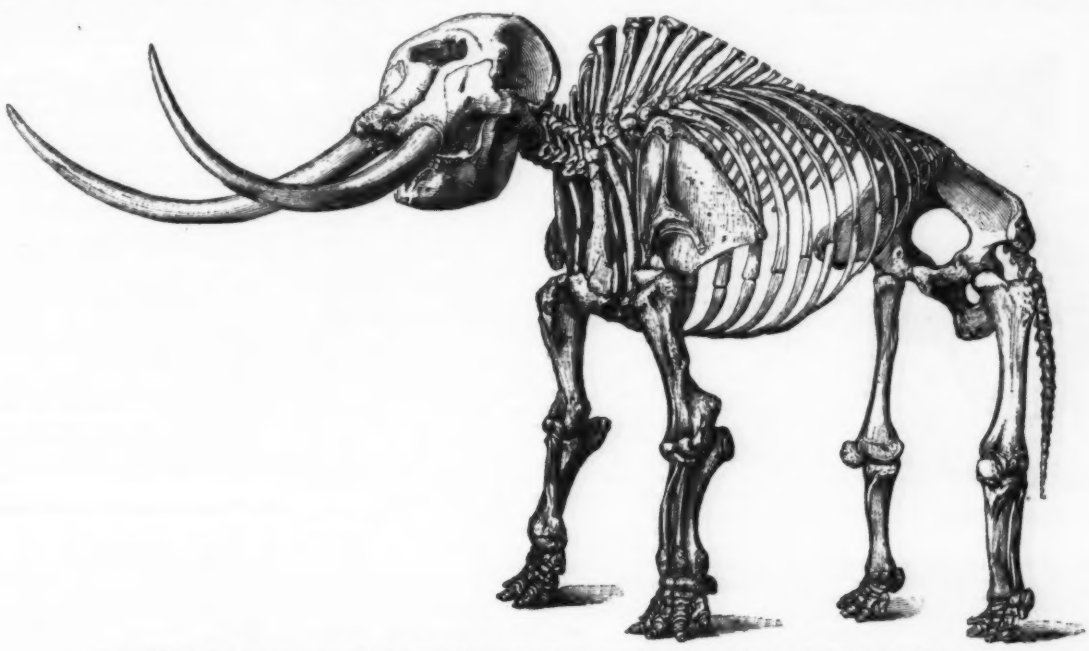
Additional discoveries have since brought to light more perfect specimens, one of which, now in the Yale Museum, is perhaps in the best preservation of any skeleton of the American *mastodon* yet discovered, and this has been used by the writer in the restoration, one thirty-second natural size, given herewith, which is reduced from a large drawing made for the United States Geological Survey.

The position chosen in this restoration is one which seems especially fitted to bring out the massive proportions of the animal, and, at the same time, to show nearly all the characteristic features of the entire skeleton. The animal as thus represented was, when alive, about twelve feet in height, and perhaps twenty-four feet in length, including the tusks.

This animal was fully adult, as the last molars above and below are in place and somewhat worn. The epiphyses of the vertebræ, moreover, are nearly all coössified with the centra, and in some of them the sutures are obliterated. The epiphyses are also firmly united to the limb bones.

The tusks were very large, and considerably divergent. There were no inferior tusks, and no traces of their alveoli remain. The penultimate and last molars are present above and below in fine preservation, the former considerably worn.

Other features of this skeleton, and especially the various new anatomical points it discloses, will be discussed by the writer in another communication.



RESTORATION OF MASTODON AMERICANUS, Cuvier. (One thirty-second natural size.)

## THE DOGWOODS.

THE genus Cornus contains about twenty-five species and is widely distributed throughout the northern hemisphere. Some are small herbaceous plants, others are dwarf shrubs, and some attain tree dimensions; none are evergreen. A few of the most desirable species are mentioned below:

*Cornus Kousa*, a Japanese plant first introduced by Messrs. J. Veitch & Son several years ago, and exhibited by them in excellent condition at one of the meetings of the Royal Horticultural Society during the past summer, makes amends for some of its relatives, which either do not flower or flower rarely in England, or only grow in the extreme south or southwest.

C. Kousa (or Benthamia japonica, as it used to be called) makes a fine addition to our list of hardy ornamental shrubs. It is found wild in the mountains of Nippon and elsewhere at elevations of about 4,000 ft., and flowers in May and June. The great beauty of the plant consists in the large white floral leaves or bracts; the true flowers are small, and crowded together in the center of the four bracts. The succulent fruits ripen in autumn, are of a fine red color, and have an agreeable taste—at least so say the authors of "Flora Japonica."

*C. florida.*—A native of the Southeastern United States, and, as seen in a wild state, one of the most beautiful of trees. The great attraction resides in the four or five large, broad, white bracts which subtend the inconspicuous flowers. So showy are these bracts and so abundantly are they produced under suitable conditions that the trees are clothed with a mass of dazzling white. It is a great pity that in this country C. florida, although quite hardy, rarely flowers; this is probably due to the fact that our summers are not hot enough to properly ripen the wood. On the Continent, in places where the winters are much more severe than with us, but, on the other hand, where the summers are hotter, the Florida dogwood makes a glorious object in the garden or shrubbery. Perhaps, if it were grown against a sunny wall, the wood would get baked and ripened sufficiently to produce flowers. This and a red-flowered form, which would make a glorious companion, would, in all probability, well repay any trouble in pruning and treating as wall plants in England. The red-flowered dogwood was discovered wild a few years ago, and has been propagated and widely distributed by American nurserymen. The type, even apart from the beauty of the flowers, is well worth growing for the gorgeous autumnal crimson tints assumed by the decaying leaves.

*C. Nuttallii*, from the opposite side of the North American continent to C. florida, is even a finer species than the last, the so-called flowers sometimes measuring upward of five inches across; as in the last the true flowers are insignificant, and closely packed together, the four white bracts giving the inflorescence, at a short distance, the appearance of a clematis flower. A fine painting of this species to be seen in the "North" gallery at Kew. C. Nuttallii has not been long in cultivation in Britain; whether it will prove more free flowering than C. florida in this country remains to be seen.

*C. capitata* extends in a wild state from North India to China. In Cornwall it makes a very beautiful shrub or tree. Like the three last named species, it has large, showy, petal-like white bracts. The flowers are followed by large, red fruits, not unlike strawberries; these are eaten in India. This species are not nearly so hardy as the two first mentioned ones. It will not withstand a severe winter in the open ground in the neighborhood of London; and we have seen a plant cultivated against a wall for many years, but the hopes of seeing flowers produced by it have so far been disappointed. In Cornwall we have seen specimens as large as medium sized apple trees, and certainly C. capitata—also known as Benthamia fragifera—is one of the handsomest of the large series of ornamental trees and shrubs cultivated in that favored country.

*C. alba* occurs wild from Siberia to China; it is named alba on account of its white, mistletoe-like fruits. This species makes a dense mass in the shrubbery, and, where space can be afforded, it is well worth growing. It flowers in May and June. In winter the fine red color of the naked branches renders it conspicuous. One of the very finest variegated plants introduced within recent years is C. alba Spathii, distributed a few years ago by the celebrated Berlin nurseryman after whom it is named; it grows freely, does not burn, and is quite as hardy as the type. The leaves measure about three inches in length by about one and a half in width, and have a center of bright, clear green, with a broad, irregular band of rich orange color. Add to this the bright color of the leafless twigs in winter, and it will be seen that C. alba Spathii is a very valuable acquisition. C. sibirica is really a form of C. alba, but the plant is dwarfer, and the winter coloring of the twigs more intense; it is worth growing for the fine winter effects which can be produced by means of it.

*C. mas.*—The cornel or cornelian cherry is found wild throughout Europe, and has long been cultivated in English gardens as an ornamental shrub or tree. On the Continent, however, it is grown as a fruit tree, and various forms, differing in the size and color of their fruits, have been raised and are perpetuated by grafting. C. mas is best known with us as a flowering shrub; its umbels of small bright yellow flowers being conspicuous on the leafless twigs from February onward. The bright, shining scarlet fruits, the size and form of a small acorn, are in some places produced in great abundance by old trees, which then form most beautiful objects. There are cultivated forms of cornel which have yellow and purplish fruits, and others only differ from the wild type in the fruits being larger. The wood is very hard and horny, and is used in France and elsewhere for making handles of tools, such as hammers, shovels, etc. C. mas variegata is a pretty variety quite constant in character; its leaves are nicely margined with white. C. mas elegantissima is a tricolor form distributed many years ago by Messrs. C. Lee & Son; where it thrives, the gold, red and green of the foliage produce fine color effects.

*C. sanguinea.*—Our native dogwood owes its specific name to the intense color assumed by the decaying leaves in autumn. It is a suitable thing to plant on the margins of a plantation, or by the side of a woodland walk, and is one of the commonest occupants of the shrubbery in old-fashioned gardens. The species is widely distributed throughout the northern hemisphere. Formerly the wood was used for arrows; it is now employed in the manufacture of gunpowder. A variety (candidissima), with yellow-green bark and lighter green leaves, is dwarfer in habit than the wild type, to which it forms an interesting contrast.—*George Nicholson, in the Gardeners' Magazine.*

## LARYNGECTOMY.

DR. J. SOLIS-COHEN has published in the *Maryland Medical Journal* for July 16 a report of the successful removal of a larynx for malignant disease. The case had been under the investigation of laryngologists for about twenty years, and Dr. Lefferts had reported upon it in 1876 concerning his removal of a large papilloma by an intralaryngeal operation. After ten years of comparative freedom from discomfort, a recurrence of painful symptoms began, and the case grew worse, until, in January last, the patient applied at the dispensary of the Jefferson Medical College. After a preliminary tracheotomy had been performed, operations with forceps and by other means removed parts of the tumor, which at the time was held by the microscopists who examined the specimens to be sarcomatous.

These operations improved the patient's condition temporarily only, and extirpation was proposed. The patient consented, and on April 1 the radical procedure was undertaken. The incision was everywhere made through healthy structure. The diseased skin and adjacent morbid tissues were circumscribed by elliptical incisions through the sound skin, these latter being carried gradually deeper until with the fingers the larynx could be separated from the underlying parts. A tampon cannula resembling Trendelenburg's was then substituted for the ordinary cannula. Anæsthesia by chloroform was continued through the substituted cannula, as it had before been effected through the simple cannula. The larynx was cut away, sparing the œsophagus entire, going down to the first ring of the trachea. The soft parts were brought loosely together with sutures, leaving a space at the upper portion of the wound for the insertion of a soft rubber stomach tube. The operation occupied an hour. Dr. Solis-Cohen remained with his patient for sixteen hours, and otherwise insured an unceasing watch over the case for several days. Two members of the staff spent eight hours with the man, and during that period saved his life twice, death by suffocation from clogging of the cannula with mucus being imminent. The close attention given the case for eighty hours by the hospital attaches insured the man's survival from the dangers of the operation. The œsophageal tube did not appear to be necessary, and was removed on the third day. Enemata were used for four days, when gradually feeding by the mouth was resumed. Recovery was uninterrupted. No attempt has yet been made to introduce a voice tube, for two reasons: first, no such tube has been at command; second, the indications are imperative, in the mind of the surgeon, to keep the wound free from all possible sources of irritation until the question of the recurrence of the growth has been answered. Of the nature of the tumor removed the author does not speak positively, but it is evident that he inclines to the belief that it was no longer benign in character at the time of its removal. The reports of the microscopists are

* British Fossil Mammals and Birds, figure 102, p. 298, London, 1846.

† Description of a skeleton of the *Mastodon giganteus* of North America, plate xxvii., Boston, 1852.

‡ Report of the New York State Cabinet of Natural History for the year 1867, plate vi., Albany, 1871.

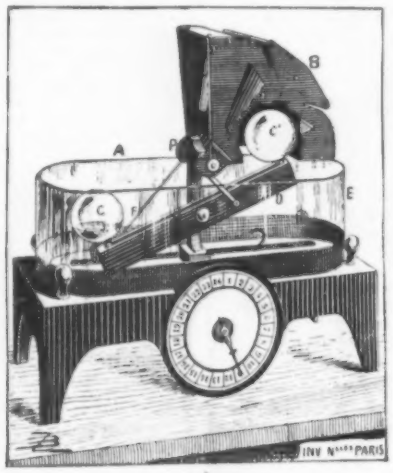
not in full harmony. The author believes that an interval of some years occurred between the date of the removal of the papilloma and that of the malignant development on the site of the old cicatrix. He draws not a few instructive deductions from the course of his case, but we have space only for the following: "There is one clinical point, which has been a revelation to me—that is, the freedom from pain, from cough, and from dysphagia. Should there be no recurrence in this case, we have every reason to be satisfied with the result. Should recurrence ensue, the patient will have been relieved from suffering for some time." The patient is now wearing a single rectangular tube with a very slight amount of paraphernalia.

At the German Surgical Congress, held in June, Dr. Julius Wolff was able to present a patient who had undergone the operation for relief from carcinoma. After other surgeons in Berlin had refused to take the case, Dr. Wolff had done the operation, and, by the kind assistance of Du Bois-Reymond, an artificial larynx had been constructed. With it the patient could not only speak, but even make some attempts at singing.—*N. Y. Med. Jour.*

## THE SOLARIMETER.

THE apparatus here figured is a sort of thermoscope, whose two glass balls, C and C', are mounted upon a wooden balance, D, movable around a horizontal axis.

A screen, B, placed at the upper part of the apparatus, is likewise capable of revolving around an axis parallel with the preceding. The screen is balanced by means of a counterpoise placed at the bottom of a rod, F, whose upper extremity, P, is fixed to the screen. The whole is surrounded by a glass case, A, serving as a protection and facilitating insolation. The thermoscope contains a volatile liquid. If the apparatus is exposed to the rays of the sun, the lower ball, C, into which the liquid runs through gravity, soon becomes heated, while the ball, C', remains sensibly at the same temperature, owing to the shelter afforded by the screen, whose sides intercept the rays while at the same time allowing of a free circulation of the air. At a given moment, the tension of the vapors of the ball, C, is sufficient to force back the liquid into the upper ball, to which it is led by the tube that unites




THE SOLARIMETER.

the two spheres. The equilibrium is then destroyed and the balance, D, oscillates around its center. The ball, C, then rises, while C' descends to the interior of the glass case, A. This rocking motion is transmitted through a small connecting rod to the screen, B, which then moves to the left to cover the ball, C, in its new position. The balls being thus successively exposed to the solar rays and sheltered by the screen, will give the balance an alternating motion, each double oscillation of which is registered upon a dial by a hand moved by a metallic rod seen to the right of the figure. It will be seen that by giving this apparatus large enough dimensions it is possible to realize a means of utilizing solar heat.—*Les Inventions Nouvelles.*

## NEW METHOD OF DETERMINING THE MAGNITUDE OF MOLECULES.

By G. JAGER.

IF it be assumed that molecules are minute droplets, which are formed from larger ones by impact against and repulsion from solid walls, and which ultimately acquire a definite mean value for a given temperature, seeing that a division is only possible as long as the *vis viva* with which the drop strikes against a wall is greater than the work necessary for the division; in this case we obtain a limiting value for this magnitude. If it be assumed that all droplets are of the same size, then the drops from which they are formed must be at least twice as large. We have therefore to determine the increase of surface when a sphere is divided into two equal parts of spherical form. This, multiplied by the capillary constant $a$, gives the work $4\pi(3-\sqrt[3]{4})r^2a$, if $r$ is the radius of the partial spheres. This work must be equal to $\frac{1}{2}\pi r^3\rho\omega^2$; that is, the *vis viva* of the original sphere, if $\rho$ is the density of the liquid, and $\omega^2$ the mean square of the velocity. From this we get $r=1{\cdot}24a/\rho\omega^2$ as radius of the molecules. The values obtained by this method agree very well with the results of other methods.

| | $\delta$ | |
|---|---|---|
| Water | $51{\cdot}10^{-8}$ | centim. |
| Ether | 76 | " |
| Alcohol | 52 | " |
| Methylic alcohol | 77 | " |
| Carbon bisulphide | 73 | " |
| Chloroform | 80 | " |
| Aceton | 31 | " |

—*Wiener Berichte*, vol. c., p. 1122 (1891); from *Beiblätter der Physik*, vol. xvi., p. 345 (1892); *Phil. Mag.*

## SUCCINIC ACID AS A PRODUCT OF FERMENTATION.

PASTEUR observed that in fermentation 100 parts of sugar yielded on the average 0·673 succinic acid and 3·64 of glycerin in the proportion of 1·5. He inferred that a part of the sugar is split up according to the equation—

$$49C_{12}H_{22}O_{11}+109H_2O = 24C_4H_6O_4+144C_3H_8O_3+60CO_2.$$

On the contrary, the investigations of Thylmann and Helgen show that the amount of glycerin produced varies according to the temperature, access of air, etc. Rau has since found that there is similar variation in the quantity of succinic acid produced, and he arrives at the conclusion that the formation of this acid in fermentation is independent of the formation of glycerin, being a normal result of the action of yeast affected by various conditions.—*Ach. f. Hygien.*, 1892, xiv., 225.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